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THE PEASANT PROBLEM IN YUGOSLAVIA

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Ye friends to truth, ye statesmen, who survey
The rich man's joys increase, the poor's decay,
'Tis yours to judge how wide the limits stand
Between a splendid and a happy land.
—*Goldsmith, "The Deserted Village."*

Introduction

The Balkan region, long notorious as the "cockpit of Europe," is characterized by a deep-seated restlessness and unstability. Probably because of the war, all seems quiet for the moment, but almost anything may relight the fuse, and irredentisms will again become assertive, and governments again be overthrown at record rates. Turbulence, feuds and corruption are indeed the heritage of centuries of Turkish misgovernment, but these evils have been accentuated, if anything —especially since the World War—by the conflicting Near Eastern policies of the Great Powers.

For hundreds of years the Balkan area has served as a roadway for many people of varied racial strains who migrated from the steppes of Russia and from Asia Minor into Europe, with the result that national lines are notoriously vague. For example, there are many cases of small cultural islands made up of one human group, surrounded by people of an entirely different racial strain, who speak a different language, have a different religion and cultural heritage. But this has not prevented the growth of militant nationalisms. Each group, whether relatively pure or obviously mixed racially, jealously maintains its heroic legends, and feels that it has a mission to fulfil. Very often the groups have been encouraged in their demands by some interested Great Power, and all too frequently missions of rival nationalisms have clashed. Many post-war political units contained several minority groups, each of which remains true to its cultural traditions, its language, its religion. And each longs—or is encouraged by propaganda to long —for reunion with its homeland.

The Croatian Peasant and His Historical Background

In an attempt to analyze some of the developments in the Balkan area as a whole, it is proposed to make a rather intensive study of conditions in a typical "Balkan Case"—Yugoslavia—particularly of conditions affecting the Croatian peasants, who form some 80 per cent. of the population in the Croatian province. Perhaps it will be possible to reach conclusions that will be valid for other countries of southeastern Europe.

The Croatian peasant is, like most peasants, generally conservative, but not culturally backward. Since he has been close to the soil for centuries, he is stolid and rather hard to change; but when he does have a good idea and comes to value

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RELIEF MAP OF YUGOSLAVIA

it, he will cling to it tenaciously, even if he may suffer by so doing. Out of the love for his piece of land and his village there has grown up in him a love of country which is nationalist in the truest sense of that word. Even under the dictatorship he unfurled his Croatian flag with little regard for persecution which he was to suffer at the hands of the Beograde régime. In spite of differences in mentality in the various parts of Croatia, there is one characteristic common to the entire people, namely, their willingness to fight for their old rights (*stare pravice*) against all odds.

The peasants in pre-war Croatia and Slovenia vegetated under a feudal régime similar to that prevalent in western Europe during the Middle Ages. Great landed estates were the rule, and the great land-owners were the highest court of appeal for the peasants on their land. The peasants were serfs, bound to the soil. They paid the landlords in crops and personal services. This serfdom (*Kmetstvo*) was abolished only after the war. There were very few free peasants (*slobodnjaci*).

In Dalmatia and Istria there existed a modification of the feudal system. There

the peasant rented the land and gave part of the crops in payment—in other words, he was a share cropper. This system, with its familiar abuses, has by no means disappeared, in spite of the laws of 1925 and of 1929 which were passed primarily to abolish it. In Bosnia and Herzegovina also the feudal pattern existed, but there the landlords were Moslems—a condition resulting from the Turkish invasion. Christians could be only serfs or free peasants—not landholders. In 1915 there were 96,000 serfs, 151,000 free peasants and perhaps 10,000 Bey and Aga families (landlords). The free peasants were almost all Moslems. Serfdom was abolished after the war, but the agrarian reform was carried out in such a way that the peasant class was impoverished and the arable lands greatly reduced compared to what they were before the war.

Post-War Agrarian Reform: Breaking up of Great Landed Estates[1]

In the provinces of Slovenia, Croatia-Slavonia and Voyvodina there were 720 great landed estates with a total area of 1,277,040 hectares (3,154,300 acres), of which 555,137 hectares were expropriated. Titles to 367,084 hectares of this land were given to 312,175 families, who were living on these estates at the time of expropriation. This means that only a little more than a hectare (2.47 acres) was received by each family. In addition, 8,736 families were brought in from other areas and settled on 41,497 hectares, or 5 hectares per family; 7,289 families of war veterans of different classes received title to 52,344 hectares, or 7 hectares per family; and finally, 13,059

[1] Dr. Josef März, "Jugoslawien, Probleme aus Raum, Volk und Wirtschaft," pp. 41–43, Berlin, 1938.

FIG. 1. HAYING TIME NEAR KRAPINSKE TOPLICE.

WITH BOTH MEN AND WOMEN AT WORK IN THE FIELDS. THE HAYFIELDS ARE ON THE VALLEY FLOORS AND THE FOOD CROP ON THE SIDES OF THE HILLS. NOTE THE HOUSE OF A FORMER LARGE LANDHOLDER IN THE LEFT BACKGROUND.

FIG. 2. RURAL SCENE NEAR KRAPINSKE TOPLICE.
WHERE THE WHITEWASHED HOMES OF THE PEASANTS ARE NEAR THEIR FIELDS.

families of new settlers of various categories were given 94,212 hectares, or about 7 hectares per family.

In Dalmatia the share-cropper system was abolished—at least on the statute books—and 97,000 families were given possession of the land they had long cultivated—50,000 hectares, almost all of which was in very small plots planted in grapes.

The great feudal estates of Bosnia and Herzegovina were divided up among various classes of people. First, the 217,000 families who were already farming the land were given 1,227,028 hectares, or an average of 6 hectares (15 acres) per family, while 28,294 families of new settlers received 36,784 hectares, an average of only 1½ hectares (3.7 acres) per family, an area obviously much too small. The 4,483 war veterans received 22,515 hectares, or 5 hectares (12.4 acres) per family.

Social conditions were largely responsible for these reforms. With years of war behind them and starvation staring them in the face, many peasants were ready to fall upon the great estates and divide up the land without benefit of government decree. The peasant war veterans who had become accustomed to violence and the use of force and who had heard vague rumors about what had happened in Russia, clamored for land, and in no uncertain terms. To these discontented classes the new government threw land reform as a sop and gave the appearance of legality to what the peasants were ready to do violently. Little heed was given to economic considerations, and the plots were often too small. Moreover, many landlords then felt relieved entirely of any responsibility towards the peasants on their lands. To be sure, they had never given them much thought; the reform was an excuse for giving them none at all. Furthermore, the landlords were paid, at least in part, and they con-

FIG. 3. NEVER-FAILING CROP—CHILDREN OF ONE PEASANT FAMILY.
SLAVIC TYPES. THREE CHILDREN WERE ABSENT, GATHERING FIREWOOD AND TENDING THE COWS.

tinued to live. After what had happened in Russia they were glad to preserve their lives, together with a part of their prerogatives, and to prevent a violent revolution of the peasantry.

Peasant Life Near Krapinske Toplice

The little village of Krapinske Toplice is set in a frame of intensively cultivated rounded hills. This is a densely populated area of Tertiary hill lands, on the slopes of which woods and fields under cultivation form pleasing patchwork patterns and at the foot of which streams meander sluggishly through hayfields and pastures. The whitewashed homes of the peasants are another note of beauty in this picturesque cultural landscape (Fig. 1).

One of the first things that strikes the eye of the observer is the hay fields on the valley floors and the food crops on the sides of the hills, some of which are steep, the reverse of what one would expect. In this region, only hay will thrive on the valley floors because they are poorly drained and swampy, a condition due to the fact that the Sava River and its tributaries have reached a temporary base level at the mountain barrier through which the gorge of the Iron Gate has been cut. Only after this obstacle has been eliminated and the streams above it have cut down to a new base level can the valley floors be drained. This factor plays a part in the economy of the region at present, but, as we shall see, it is by no means the most important one.

Relatively few peasants live in the villages, for they prefer to have their homes on or near their fields. Their main food crop is corn (maize), which grows well in the hot summers and which can be raised with beans and pumpkins under a system of interculture, thus materially increas-

ing the yield of foodstuffs per acre. Both men and women work long hours in their fields during the summer (Fig. 2). There are few fences, except along roads. The small plots of wheat are cut by hand, every stock being carefully gathered; there are no gleaners, because there is not one head of wheat lost.

In this rather primitive rural economy children are considered an asset, not a liability. Families of eight or ten living children are common, in spite of a very high rate of infant mortality (Fig. 3). Of course, the peasant knows nothing of birth control methods, and probably if he did he would not care to practice them. Furthermore, a child becomes a valuable part of the economic unit in a short time. He tends cows along the roads or between the fields at a very tender age, so that every bit of hay can be saved for winter use. He can also collect and carry home small branches of trees for firewood, and later can cut them into suitable lengths for burning.

The lives of these peasants are certainly meager in the extreme. They seldom have meat to eat—hogs, calves, chickens and ducks must be sold for cash, as well as milk, butter and cheese in many cases. And these products are sold—if a buyer is found at all—in a buyer's market. At the little hotel in Krapinske a peasant was asking 15 dinar (one dinar equals approximately 2 cents in American money) for a big fat duck—and was unable to sell it even at that price. Excellent cheese that must have required months to make sold for 15 dinar the kilo. The man of all work at the hotel—interpreter, bell-hop, janitor—received his keep and 300 dinar a month for his services. His tips amounted to perhaps the same amount. On this he had to support his wife and four children at Zagreb. Their standard of living can be imagined. As he pointed out, he was very unfortunate in having four daughters, for boys would go to work very young and help out at home. Furthermore, it would be no easy task to marry off the daughters because he could give them no dowries.

The land in this area rates only as fourth class for the country as a whole. It is well divided among the peasants. There are 8,000 people in the county and 4,890 hectares of cultivable land. This means on the average only a little more than an acre per person—a much too small acreage in a region where subsistence farming on poor land is about the only means of making a living. Some 4,000 persons have emigrated to foreign countries or to other parts of Yugoslavia, and send some money back to their families. The ten largest landholders have a total of only 86 hectares. But these 8,000 people must pay some 75,000 dinar in taxes to the local government and 125,000 to the Federal Government. This averages 25 dinar per person per year, and we shall see later what a burden taxes are to the peasantry as a whole.

Practically all work is done by hand, because the peasant has little money with which to buy tools and is almost on a subsistence basis. Even to obtain the minimum cash with which to buy the few industrial goods, such as foodstuffs and agricultural implements, which he can not do without and which he can not produce himself, he must sell half or even more of his crops. The rest is eaten by himself and his family. Under such conditions the possibility of capital accumulation is remote. Hence, there is almost no chance of buying up-to-date farm implements and fertilizer, or of introducing new farming techniques.

Sarajevo and Environs

Far to the south of Krapinske Toplice, around the city of Sarajevo, the peasants are comparatively well off. But first a few words about the town.

The site of Sarajevo is an alluvial terrace of the Miljacka River, which is set in an amphitheater of low hills made into

FIG. 4. STREET SCENE IN SARAJEVO.
TWO OLD MOSLEMS, WITH A MOSQUE AS BACKGROUND, DISCUSS THE PRICE OF HAY.

irregular patterns by fields under cultivation. These fields are separated from each other by green ribbons of oak trees, elms and beeches. The beauty of the natural landscape is heightened by the peaceful contact of the oriental Moslem world with the occidental Christian world. The groups live harmoniously together, with no proselytizing at all and very little intermarriage. Every day is market day, and any street may serve as a market place for farm produce. On a bridge across the river, with a picturesque mosque as background, two old Moslems begin the long-drawn-out process of mutual capitulation necessary before two muleloads of hay may change hands (Fig. 4).

West of Sarajevo the valley opens out on the extensive terrace of the Zeljeznica River, a turbulent mountain stream from the southeast which here suddenly loses its velocity and begins the process of aggrading its bed. The little peasant villages of Lasica, Hrasnica and Kovaci cluster along the edge of the high dark mountains like beads on a string. In such places the houses do not take up space on the fertile terrace, and the peasants in summer are able easily to go out to their long narrow plots (Fig. 5).

These peasants also have herds in the mountains, which rise immediately behind the villages (Fig. 6). Transhumance is practiced with numerous head of sheep and goats, as well as cattle, horses and mules, which are pastured in the mountains during the summer and brought back to the village in winter. Hay for winter feeding is grown just at the foot of the mountains and on the gravelly areas of the terrace. Some of the peasants keep bees. Poplars, oaks and fruit trees—especially plums—are planted in the villages and along some of the roads. In the slack season the peas-

ants may cut logs or firewood, or burn charcoal in the mountains for sale in Sarajevo (Fig. 7), where there is a good market for farm and forest products the year round. The government-run resort of Banja Ilidza is a good market in the summer time, and many of the nearby peasants are engaged in intensive garden agriculture. Thus peasant life here is fairly well integrated, largely because of the possibility of diversification and proximity to good markets. Furthermore, urban industries, such as carpet-weaving, leather-tanning and basket-making, absorb some of the surplus rural population.

Mostar and Environs

In going south and west from Sarajevo along the Neretva River the continental type of climate gradually gives way to the Mediterranean. The Mediterranean influence is particularly marked in the vicinity of Mostar (Fig. 8). This town grew up where the Neretva River has cut a gorge in resistant limestone, where it could easily control the river crossing as well as the trade up and down the valley. The sun, in the summer, shines down mercilessly upon this little town in its setting of limestone mountains. Figs, olives, grapes and pomegranates ripen along the stream on terraces of recently deposited gravels which have formed conglomerates. The presence of these fruits announces the proximity of the Mediterranean, as do the stone houses of the peasants, agglomerated in a few villages.

On the limestone mountains themselves, sheep crop the sparse grass and shrubs, and the poverty-stricken peasant lives in a stone house which blends perfectly with its surroundings. He grows potatoes and a few vegetables on tiny plots protected by stone walls. The peasant wife busies herself with spinning

FIG. 5. THE VILLAGE OF HRASNICA NEAR SARAJEVO.
LONG NARROW PLOTS UNDER PEASANT CULTIVATION ON THE FERTILE SOIL BEYOND. HAY IS GROWN IN LESS FERTILE SOIL IN THE FOREGROUND. IN THE LEFT FOREGROUND IS A ROW OF BEE HIVES.

woolen thread as she walks along on one of her rare trips to town to market a little surplus produce or to buy some meager supplies (Fig. 9). A short distance downstream from Mostar the valley widens, the terraces are more extensive, and wheat and tobacco are grown. Here the peasants have a slightly higher standard of living than immediately around Mostar.

The Polje Landscape and the Human Response

A continuation of our journey to the Dalmatian Coast across this Karst country takes us through the Polje River valley, which has given its name to a type of landscape that is unique in the world. The Popovo Polje is a valley in the form of a great flat-bottomed trough which stretches for some thirty miles between the towns of Gabela and Hum and through which the Mostar-Dubrovnik railroad has been built. During the winter this entire valley is filled with water to a depth in places of 100 feet or even more and forms a sort of finger lake. Since the underlying rock is limestone, the river has no surface outlet and the water gradually seeps away in the course of the winter. All that can be seen of the river in summer is a bright ribbon meandering across valley bottoms, as flat as a billiard table and noted for their fertility (Fig. 10). The fields are laid out as regularly as the squares on a checkerboard, and are planted mostly in corn. In the upstream valley bottoms, which dry up first, corn may be knee high when it is just being planted near Gabela, where the river ends by going underground.

The peasants have built their villages on the alluvial fans along the valley, high enough to be safe from the winter flood. Here they overlook their corn and to-

FIG. 6. VIEW DOWN MAIN STREET OF THE VILLAGE OF LASICA. NEAR SARAJEVO. HOUSES OF WOOD, WITH VERY STEEP CLAPBOARD ROOFS. NOTE HEAVILY WOODED MOUNTAINS IN THE BACKGROUND.

bacco fields on the valley floors, and are near their vineyards and fig and olive groves which grow on the terraced fields of the alluvial fans (Fig. 11). Behind them rise the mountains of Mesozoic limestone, where sheep and goats, tended by the children, crop the sparse xerophytic vegetation. Wool from these animals is made into homespun clothes for the entire family, and if there is any surplus, it is sold for cash or bartered for food products. The peasants live a life of local self-sufficiency. Little cash is used, and that which is obtained goes mostly for taxes.

The Doline Landscape

In most of the limestone areas of Dalmatia there are many isolated depressions which have no visible outlets, especially during the last few hours of a journey to Dubrovnik. During long periods of time rain-water has collected in them and gradually seeped out below, leaving a little soil in these sinks on which a few peasants eke out a meager existence (Fig. 12). The main crops on the very small plots, on which an infinite amount of time is spent, are wheat and potatoes. Every one eats as much as he can of these crops till about Christmas time, when the supply begins to run low. Then the family hog is killed, after which there is plenty to eat for a few days. The meat that is not eaten fresh is smoked in the house. This is not a difficult procedure, since the house has no chimney; the smoke from the meager fire of small twigs finds its way out through the low door. Constant breathing of the smoke-filled air is hard on the lungs, and there is small wonder that so many peasants in this region suffer from tuberculosis. During the season from harvest till shortly after Christmas, when food is plentiful, many peasants gain from 20 to 30 pounds in weight. But then comes the season of lean meals, when the main dish for months is soup made of rasčik—a kind of coarse cabbage which resists

FIG. 7. STREET SCENE IN SARAJEVO.

TWO MOSLEM CHARCOAL VENDORS IN FROM THE MOUNTAINS PEDDLING THEIR PRODUCT. ON THE RIGHT IS ONE OF THE SPLENDID VEGETABLE AND FRUIT MARKETS FOR WHICH THE CITY IS NOTED.

FIG. 8. A VIEW OF PART OF THE CITY OF MOSTAR.
WITH ITS BACKGROUND OF MOSTAR, AND OF LIMESTONE MOUNTAINS, ON WHICH A FEW SHEEP AND GOATS GRAZE. THE MEDITERRANEAN INFLUENCE IS SEEN IN THE BARE LIMESTONE MOUNTAINS, THE TERRACED ALLUVIAL SLOPES, AND SUCH CROPS AS GRAPES AND OLIVES. CONTRAST THESE MOUNTAINS WITH THOSE IN FIG. 6.

the cold winter wind from the continent, the *bora*. On this diet the peasant is able to keep alive till spring, when he begins to till the fields again.

There is a division of labor within the household. The man grubs the soil, plows and cares for the farm animals, if any. The woman cooks, takes care of the children, spins, weaves, knits and also serves as a pack animal. She helps bring in the harvest and carries the grain to the mill to be ground—sometimes great distances.

Peasants who can live in such an environment and thrive are tough. They often make excellent students if they can only get to a school. But even with an education they may find it impossible to get work. The field of medicine is to some extent preempted by the sons of doctors, and that of law, by sons of lawyers. Hence an educated peasant may be forced into free-lance journalism and from there into politics. He is dissatisfied with his lot and with the lot of his people at home. He feels that he thinks better when asleep than do those peasants without the advantage of an education when wide awake. Therefore he must awaken them. He points out that they live on a very low plane; that the Beograde régime is not at all interested in their plight; and that local autonomy would do a lot toward solving their problems. Since the peasants can see very little good that the central régime has done them, they fall in line, feeling that any change would be for the better.

DALMATIA, THE YUGOSLAV RIVIERA

At last we reach the heights overlook-

FIG. 9. A PEASANT WOMAN.
IN MOSTAR TO BUY SUPPLIES, ABSORBED IN HER TASK OF SPINNING WOOLEN THREAD.

ing the Dalmatian Coast and gradually descend to the port of Dubrovnik, a beautiful city of the Middle Ages on this picturesque Riviera, flanked by vineyards and cypress trees.

Dalmatia is a narrow strip of land which runs for some 300 miles along the Adriatic, with several hundred islands close to the mainland. This is the classic Karst region, with only here and there a bit of level fertile ground along the coast, always flanked by dull gray limestone mountains which are quite arid, with that complete "lifelessness" which characterizes the landscape of the moon. Wherever the mountains stand back from the shore, little villages have grown up in the midst of tiny terraced fields and garden plots—some no larger than a square yard. Vineyards, fig, orange and olive groves stretch in places for miles along the coast. The reddish brown of the terraced fields, the dark green of the vineyards and the dusty gray limestone mountains are a never-to-be-forgotten sight.

But the peasants are poor—very poor. Tremendous labor must be expended if they are to eke out the barest living from their tiny plots. Fourteen hours of labor a day are usual in the summer-time, and a man can be hired to work these hours for fifteen dinar and food. During the off-season he probably works for the government, but even then he puts in eleven hours for only twelve dinar.

A great deal of wine was once made along this coast and shipped to Vienna and the highly industrialized centers of the old Austro-Hungarian empire, a market which has been hermetically sealed by the erection of high tariff walls. Furthermore, there are the taxes. Wine must pay a 10 per cent. transportation tax if it is moved from the place where it was produced. The result is that less and less is made. In many instances the vines have been pulled up

and the plots planted in potatoes or wheat, which the peasants consume at home. Tobacco is a government monopoly, and a peasant must buy a permit in order to raise it. But since the cost of the permit is almost prohibitive, a great deal is grown illegally. The government seems to ignore the fact that trade brings wealth. By putting prohibitive taxes on many products the peasants are driven to the most primitive sort of self-sufficiency.

The Development of Cooperatives

In many of the countries of Europe the modernization of agriculture has coincided with a development of collectives. When the peasant has to change the economy from that of the local self-sufficiency of a feudal estate to a money economy, agricultural production must change. Formerly he raised only what he needed, and if there was a surplus, the marketing was done by the landlord; now he must produce for the market and dispose of his produce himself. In order to do this he must have enough capital to introduce new and more intensive methods of production. There is now less emphasis on labor, more on capital. Hence the peasant must have credit, but therein lies the danger. He can get credit from the banks or from the local money lenders. Since as a rule the government agencies tend to finance only the well-off peasants or great landlords, the small peasant is driven to seek credit from the local money lender, whose rates are very high. Since the peasant often can not make enough to pay the interest, not to mention the principal, he soon finds himself in debt, working for his creditor or creditors instead of for himself. This condition con-

FIG. 10. THE POLJE RIVER NEAR GABELA.
WHERE IT DISAPPEARS UNDERGROUND. NOT TILL EARLY JULY DOES THE SOIL GET DRY ENOUGH TO WORK. NOTE STONE HOUSES WITHOUT CHIMNEYS IN THE FOREGROUND.

FIG. 11. A VIEW ACROSS THE POLJE VALLEY NEAR HUM.
HERE THE PEASANT VILLAGES ARE LOCATED ON THE ALLUVIAL FANS. IN THIS UPPER PART OF THE VALLEY THE CORN IS ALREADY SOME TEN INCHES HIGH.

tinues till his plot of land comes under the hammer in order to pay his debt. Then he joins the proletariat in the city or becomes a day laborer in his village. A great many peasants have met this very fate, although they have attempted to defend themselves against it in many ways, one of the most important of which has been the development of collectives.

In former times there existed in Croatia a kind of patriarchal community organization of society. All the grown male members of a tiny community chose the head man ("gospodar," gazda), who was vested with a great deal of authority, but who could be deposed as soon as the majority felt that he was no longer furthering the best interests of the community unit. Thus the peasant has had a sense of a truly democratic scheme of life, in which society is so ordered that it expresses the will of the people—at least of those in his community. They like to have some one in authority as long as he can be recalled when he no longer truly represents their interests. But now the authority of the gospodar has been assumed by the state, which is not so easily changed.

Most of the farm units of Croatia are very small, and these necessitate work in common much more than the large undertakings. The small holders are dependent upon each other to a great extent, for only by close cooperation can they harvest and market their produce. Cooperation was not new, since the peasants had long lived under the patriarchal system in which one or more families worked their land in common. Each member, irrespective of age and sex, had a right to the use of the common property. Socially the "zadrugé," or collective, was a community bound to-

gether by blood ties; economically it was a collective. Long before the war there was a well developed system of these local cooperatives. Unfortunately, after the war many of them were captured by aggressive modern business men who thereupon usually managed them to their own narrow advantage. But the will to cooperation is still in the heart of the peasant, which is very important. A discussion of the development of the cooperatives would be a volume in itself.[2] Suffice it to say that membership in the cooperatives has been increasing steadily each year, but that they can not yet supply the leadership and capital that it was hoped they might, in time, as has been done in Denmark.

In Russia after the revolution the state farms for awhile cultivated only 25 per cent. of their crop land; the remainder was rented out or worked by peasants on a share-cropping basis. It is to be noted that they employed and fed twice as many workers per unit of land for a given area as did the private estates before the revolution.[3] And from 1936 to 1938 the planned area under spring crops on the collective farms in the Soviet Union increased by 18,000,000 acres because they continued to show that they were more efficient producers than the state grain farms. These results would seem to point the way for the Yugoslavs. Emphasis should be on the collective farms, since the increase in that form of farm unit should certainly mean a higher standard of living for the present population.

[2] Dr. Vilko Rieger, "Das landwirtschaftliche Genossenschaftswesen in den Kroatischen Ländern," Berlin, 1939, Verlag Rudolph Pfau.

[3] W. Ladejinsky, "Soviet State Farms," *Political Science Quarterly*, 53: 1, 63, March, 1938.

FIG. 12. A DOLINE OR LIMESTONE SINK NEAR HUM.

HERE THE WATER COLLECTS AFTER RAINS AND GRADUALLY SEEPS AWAY BELOW THE SURFACE. ON THE TINY PLOTS OF SOIL A FEW PEASANTS MAKE A VERY POOR LIVING.

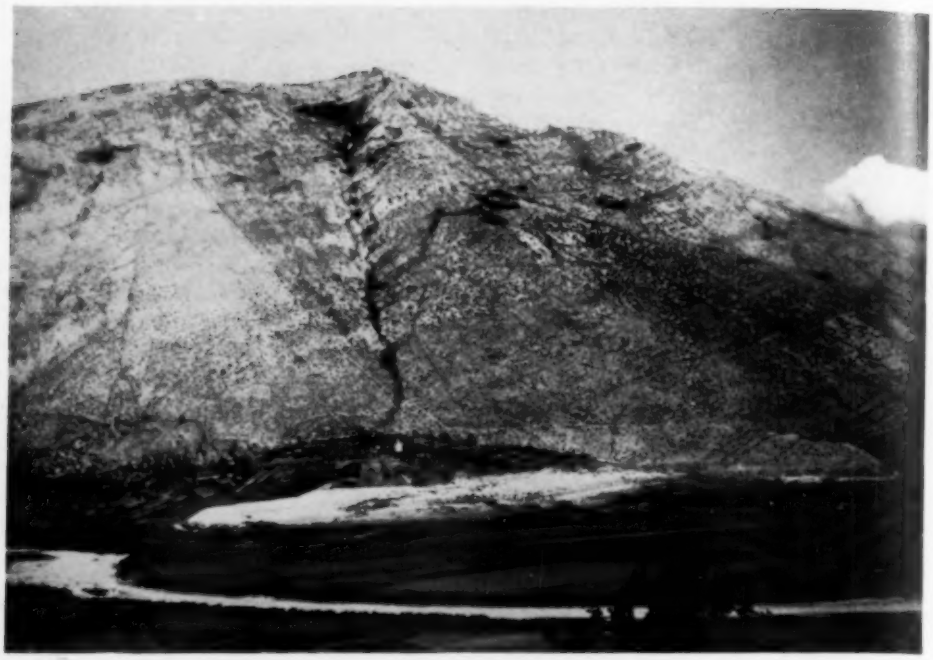

FIG. 13. A VIEW ACROSS THE POLJE VALLEY.

ABOUT HALF WAY BETWEEN GABELA AND HUM. HERE THE FIELDS HAVE BEEN PLOUGHED AND PLANTED. THE TINY PEASANT VILLAGE IS LOCATED ON THE ALLUVIAL FAN, HIGH ABOVE THE VALLEY BOTTOM, WHICH IS FLOODED IN WINTER.

Present Indebtedness

The amount of indebtedness of peasants is very great, 700,000 of the 1,780,000 of them in Croatia, or 32.5 per cent., being in debt to the extent of between 6 and 7 billion dinar. The average indebtedness for those holding up to 19 hectares is 7,000 dinar; from 10 to 30 hectares, 22,000; from 30 to 75 hectares, 63,000; and from 75 to 100 hectares, 70,000. By far the greater number of debtors are peasants with small holdings. The average indebtedness increases with the size of the unit, and is greater in those areas of advanced agriculture because more credit is necessary there. The state banks and the cooperatives have granted somewhat more than 50 per cent. of the credit (43 per cent. and 12 per cent., respectively). The rest (45 per cent.) is obtained from the private lenders, whose interest rates are as high as the traffic will bear. But the very fact that peasants will trust themselves to the tender mercies of these loan sharks shows what a crying need there is for capital. During the worst depression years there was a tremendous demand for credit for consumer goods. Fortunately, the collectives were in a position to meet much of this demand and thereby improve the condition of the small peasant. Furthermore, by giving some competition to the private money lender, the collectives were able to keep the interest rates somewhat lower generally than they otherwise would have been.

Seven tenths to four fifths of all the debts at the banks have been contracted by peasants. In the autumn of 1936, under the régime of Stojadinowitsch, a moratorium was declared on all these

debts. But if the peasants are ever to pay this money they must have markets for their produce. If their debts are permanently cancelled the banks will cease to function. Where further capital is to come from is the burning question.

The Tax Burden and the Peasant

Before the war 11 kilograms of wheat sufficed to pay the taxes to the state on a "Joch" of land, whereas now it takes on the average 26 kilos. When the local, county and village taxes and the indirect taxes on consumers goods are added to those due the Federal Government, it is apparent that the peasant could not pay them even if he wished. In 1928 the government stepped in and passed a law regarding indirect taxes based on the prices of farm products in 1925–1926. Although prices sank as much as a third or even a half, the taxes remained the same. According to the official statistics for the fiscal year 1936–1937 the federal taxes averaged 438 dinar per person, to which 104 dinar in city and county taxes must be added—542 dinar per person. This is the average for the entire country, but the tax rates are higher in Croatia than in Serbia. It is estimated that each citizen pays the state on the average at least one third of his entire cash income in direct or indirect taxes.[4] For the peasant class the percentage of cash paid to the government is even higher, and this is one of the most oppressive burdens the peasant has to bear. In some poor districts the tax collectors have stopped peasants coming from town and taken what money they had, since it was a foregone conclusion that every one without exception had back taxes to pay. To avoid this the money was frequently given the children, who went home by circuitous routes.

Hence most of the ready cash goes to the government, and the peasants have no money to buy manufactured goods. They are generally quite poorly clad. Matches may be an unheard-of luxury, and if the kitchen fire goes out coals must be obtained from a neighbor to start another. During 1932–1933 thousands of homes used no sugar or matches. And at the same time that there was almost no market—or ridiculously low prices—for their hogs, sheep and other farm produce, a large part of the peasantry was chronically undernourished. A high percentage of those examined for the army are unfit for service, and the percentage of those fit decreases each year. And the rate of infant mortality is very high—one of the highest in Europe.

Because taxes remained fixed despite the steadily falling prices of agricultural products, the collectives tried to have them lowered. Attempts at negotiation with the central authorities were first made, but without success. Then the peasants simply refused to take their produce to market till the taxes were lowered. This had the desired effect in some areas, particularly in those where the officials had been selected from the locality. The peasants were not only successful in getting taxes lowered, but they gained confidence in their collective strength as well. However, this action was less successful in the wine-producing areas of Dalmatia, where the officials are not chosen from the local communities, but are appointed in and come from Beograde. Hence they were not interested in local conditions or in trying to lower the taxes to a level at which payment would be at least remotely possible.

With reference to the policies of the central government, I will quote from some of the closing paragraphs of one of the most penetrating and prophetic books ever written on any European country—"The Native's Return," by Louis Adamic.

> The (Yugoslav) people, I mean the mass of plain people, with few exceptions, are splendid,

[4] Dr. Otto von Frangeš, "Die sozialökonomische Skrutur der jugoslawischen Landwirtschaft," p. 118, Berlin, 1937.

capable of great sacrifices; the best human material with which the rulers of a new state could start if they honestly and intelligently planned to create a good, progressive civilization. In point of rulers, however, Yugoslavia, like all the rest of the Balkans and most of Europe, could be in no worse plight. The Belgrade government is part of the post-war political gangsterism in Europe. But for the support it receives from the Western powers, the people of Yugoslavia would have swept it into the Danube and the Sava long ago. As it is, it continues to oppress or discourage nearly every virtue in the country. . . . But eventually the vitality now suppressed is sure to burst its bonds. Meantime, it will enable the people to endure all the evils and misfortunes with which the immediate future seems ready to smite them. This goes not only for Yugoslavia, but all Slavic countries in the Balkans and eastern Europe.

And again,

I see now that the salvation of the Yugoslav people and other small backward nations in that part of the world lies, clearly and inescapably, in the direction of Russia. They will have to overthrow their present racketeer rulers, from a Balkan or East European federation of collectivist national republics and, in some mutually satisfactory way, attach themselves to the U.S.S.R.

And indeed the reappearance of Russia in the Balkans has given Yugoslavia courage to resist Nazi demands. The country has no desire to increase its exports to Germany unless it is sure of payment, and it demands payment in goods that it needs and can use. It no longer wants to be a dumping ground for any and all surplus goods Germany may have on hand, regardless of quality. Yugoslavia's attitude has stiffened markedly since Rumania failed to receive the goods which the Reich promised it last spring.

In other words, the country is in the process of internal Balkanization as a result of short-sighted government policies. In a half-hearted effort to foster ownership of land by the peasants, the government has destroyed security of tenure. The result is an uprooted peasantry ready for any change that might again stick their roots deep into the earth that they have tilled for centuries.

But a bold peasantry, their country's pride,
When once destroy'd, can never be supplied.
—*Goldsmith, "The Deserted Village."*

PLANT ROOTS CONSERVE SOIL

In order to determine the relative efficiency of various cultivated crops in prevention soil erosion, Dr. Howard J. Dittmer, of Chicago, has investigated the root systems of several plants. The results will be surprising to those who are not familiar with the aggressive fight plants make for life.

It was found that the average number of roots in each cubic inch of soil in the top six inches ranged from 80 for soybeans to 2,000 for Kentucky blue grass. The total lengths of the root hairs of soybeans in a cubic inch averaged 40 feet, and in the case of blue grass more than 4,000 feet. The total surface area of the root hairs in a cubic inch averaged only 3.5 square inches, while in the case of blue grass it averaged over 200 square inches. These figures are a measure of the contact of these plants with the sub-surface world as well as of their power of presenting soil erosion. F. R. M.

ORGANISM, SOCIETY AND SCIENCE

II. SOCIETY

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In turning now to the epiorganism, I must confess at once no technical competence, yet I venture to examine how successfully our knowledge of individuals may be extended to give insight into higher order orgs in which they are units. Comparisons between societies and organisms are common enough and many familiar words and phrases imply their likeness.[3] But these are too often similes and metaphors based on highly superficial or strained resemblances rather than on true analogies or homologies. Even if the organism were but a model for the society it might be thought-provoking, for the resemblances must be based on certain common principles of organization and operation. The burning fuse and the activated iron wire are models of a nerve carrying an impulse exactly because the basic mechanism of transmission is alike in all, and study of the models has greatly furthered our understanding of the nerve.

But I can not concede that the organism is merely a model for the epiorganism any more than is the cell for the organism. If a society is an org at all, and this can hardly be denied, it is related to the organisms of which it is

[3] This essay was deliberately written without consulting the literature of sociology and so stands as an example of what can be done in the way of sociological analysis from a strictly biological approach. Since its completion, it has had the careful consideration of professional social scientists to whom I am most grateful for many stimulating criticisms and suggestions. The few of these which, to avoid misunderstanding, seemed to demand inclusion in the body of the paper are clearly set off in parentheses or footnotes.

The most consistent questionings of this approach have been: The idea of a social organism was developed by Hobbes and Spencer but was never satisfactory and has been relinquished by sociologists; and even assuming valid comparisons between organism and epiorganism, of what explanatory or predictive value are they in the understanding of human societies? As to the former, it is surely significant that a great body of biological knowledge, accumulated entirely since the early efforts to extrapolate from the individual to the group, fits in ever greater detail the society of to-day, itself evolved not inconsiderably from that of Herbert Spencer. It even directly refutes some of the more formal objections raised to this comparison—that only social units are mobile and spatially separated, play multiple roles, possess freedom of action and the like. At one time in scientific history it was also insisted that physics and chemistry could not usefully be applied to biological problems because of the new and different "vital" qualities of organic bodies not represented in inorganic matter.

This leads to the second point, viz., the possible utility of such an approach. If biological considerations merely helped to set the limits within which social actions and structures could develop (as thermodynamic knowledge tells only what physico-chemical events can occur, not which ones will), it would be valuable enough. But I suspect from my own brief experience as a sociological dabbler that much more than this is possible. In discussion with social scientists, I found without exception that the seemingly non-technical words and elementary concepts of one discipline were not understood by a follower of the other. Not understood in the most serious way, for each of us had a perfectly good set of connotations for the words we used in common, but these meanings differed enough to obstruct communication; yet sufficient discussion nearly always brought clarification and constructive agreement. Further, it carries some promise that a sociologically untutored biologist can be led by his technical knowledge of the multicellular body to conclusions about societies reached after long study of them by distinguished sociologists. I have had much personal pleasure in discovering that I have "rediscovered" parts of the work of Le Bon, McDougall, Cooley, Trotter and Durkheim, as examples.

composed, and in turn to their cells, as an org of order N+1 is to an org of order N, and as it is in turn to an org of order N−1. Since emphasis has been placed mainly on the differences between orgs of different order, upon the supposed emergence of new qualities, I find no word to express this relation of similarity. It is a type of homology,[4] perhaps "hierarchial homology" conveys the import; and the epiorganism and organism are hierarchical homologues. Their likenesses, then, when correctly seen, must have a deep significance indeed; and the transposition or extrapolation of knowledge from one to the other may lead to valid inferences which are far more than clever word pictures.

The greatest difficulty is perhaps in merely identifying the epiorganism. Between cell and organism exist many intermediate orgs—as tissues and organs; and from organism on, many others—family, neighborhood, occupational or other special group, town, nation, race, entire interspecific ecological community. In the less evolved cases, the epiorganism is fully as definitive as the organism: one colony of bacteria; one volvox ball of several thousand cell organisms; one Portuguese-man-of-war, a single cluster of hundreds of attached individuals which have differentiated into several types; one termite nest; one herd of deer or flock of geese; one isolated nomad tribe of Indians or Arabs. But an org is only semi-isolated from its environment, and the more open the interchange between them the more likely is the org to find itself incorporated in another of greater compass. When, in addition, the org itself is poorly integrated, the boundary becomes quite uncertain. For example, it is often a matter of choice where a line is drawn between one sponge with several lobes and several separate sponges. So a small backwoods village may remain to-day a fairly discrete epiorganism, while even a much larger town really in the social milieu is as clearly only part of one.

The question also arises of interspecific relations, especially that of symbiosis. A lichen is often considered to be an organism though composed of many algal and fungus individuals. A termite, except for one group, can not digest the wood it eats; this is done by symbiotic protozoa which inhabit its gut, and the sterile insect starves to death. Ants keep aphids as man does cows. There is little more reason to call a termite and its intestinal flora an epiorganism, than to call a man and his flora one. But the epiorganism which is an ant-hive might well be considered to include the commensals, and certainly human societies would be quite altered by the absence of their domesticated animals (not to mention plants!). In last analysis, all living organisms are closely enough related to one another in function (aside from descent) to constitute collectively a great epiorganism. But it will be more useful to consider mainly human groups and to focus attention on the modern industrialized nations as epiorganisms. A comparable analysis of termite colonies has been made by Emerson.

The Epiorganism

The epiorganism has definitely evolved and shows at any moment vestiges of its phylogenetic past. Our language, structures, habits carry archaic elements, as our body carries its appendix. We shall later examine the directions of change. Any individual epiorganism has also an

[4] Biologists will prefer "analogy" to "homology" here, when both are used in their technical meanings: Homologies resemble one another by virtue of common origin despite the lesser differences resulting from divergent function; analogies, despite different origin, have been forced by like function to converge in their characters. I have chosen "homology," though less defensible on this basis, to avoid the other connotations carried by "analogy" and which might misdirect the thinking of the non-biological reader.

ontogeny which roughly recapitulates the phylogeny of that species of epiorganism and is similar in separate individual cases. Groups of American Colonials, striking over the mountains westward, each independently passed through hunting, agricultural, crafts and industrial stages; while, conversely, Chinese, Malay, European and other peoples which colonized various Pacific islands, each reproduced more or less exactly its parent epiorganism. (This is not meant to imply that each new community retraces all earlier cultural epochs; nor does the embryo recapitulate the history of its species in constant or extensive detail.) Social inheritance may be as compelling as that transmitted *via* chromosomes; and the unit which has differentiated under one set of conditions may be quite unable to alter under a second. Further, the epiorganism adapts to its effective environment. The material structures it produces, the social relations developed, the mores of behavior of its units, are strikingly different in arctic or tropic climates, in plain or mountainous terrain, with peaceful or warlike neighbors or none at all, with much or little land, water and other natural resources.

The epiorganism is, of course, living, an animorg, and it manifests the major characteristics of other organisms. Dynamic equilibrium is self-evident; from day to day and year to year the social group maintains itself far more constant than does any individual in an equal time span, and this equilibrium depends upon continuous action. Its environment is tapped for free energy and a chemical stream flows through it. As the metabolism of a metazoan organism is directed to supplying its cells with nutriment, so does that of the epiorganism do so for its units. And new epiorgan systems come into being more or less hierarchically homologous to respiration, digestion, circulation and excretion—ventilation, meat packing, canning, restaurants, water and gas plants, freight and trucking, sewage and scavenger systems.

Specific synthesis of living and nonliving units is also obvious. The growth curve of a population is similar in shape to that of an individual. New units are produced by a form of autocatalysis—metazoan reproduction shares the basic characters of this—and other substances and structures are formed by simple catalysis. Cell walls, woody tubes, chitin, shells, bony and calcareous spicules, connective tissue fibres—like buildings clothes, tools, roads—are formed by the living units, acting sometimes singly and often in cooperation. The honey-comb, built by hundreds of organisms, exhibits the same mathematically perfect minimal surface and maximal volume relation as does the nautilus shell built by hundreds of cells or the foraminifera skeleton built by one. A young mammal raised on a calcium deficient diet can not construct its levers and trusses of bone but must use the poorer cartilage; the organism grows abnormally, functions, *e.g.*, moves, by different means, and may not survive. A young epiorganism of a "species" normally using iron, kept on an iron-free diet, can not build its tools and structures of iron, but must use the poorer wood or some "ersatz" material, and it develops abnormally in organization and function.

And adaptive amplification is likewise manifested by the epiorganism, though we shall hardly be surprised if this is at a relatively primitive stage. Foreign trade and manipulated currencies, trade treaties and customs' barriers, diplomatic intercourse and, especially, war are normal or emergency responses of the society to other epiorganisms, to its biotic environment. The coordinated behavior of a nation in response to acute internal (or external) disasters—hurricanes, floods, epidemics, earthquakes—affords especially clear examples of

adaptive amplification; though the less striking adjustments to more common stimuli—new inventions, ideas, problems—which accompany the gradual evolution of the epiorganism, are more common and more important. And it is obvious, of course, that society responds as a single org, though final action is performed by unit individuals (as the muscle cells in an organism), for these actions are almost all meaningless except in relation to the whole organization. Pulling a drowning man from the flood has significance at the organismic level; mailing a check to the Red Cross or sending typhoid vaccine by airplane, only at the epiorganismic one.

Individual persons are the "cells" of the epiorganism and classes of them performing like functions, vocational groups, are the tissues. The cells constituting an animal tissue are by no means always segregated spatially or grouped in some way. Fibroblasts, reticulo-endothelial cells, lymphocytes, each collectively forms a tissue, but the individual units are scattered, often singly, among cells of other types all over the body. Such dispersion is rather more common in epiorganism tissues, but there is no sharp difference introduced by the question of location. Similarly, no new problem appears with the use of non-living materials in tissues, *e.g.*, wood and bone tissue are largely dead, as are the binding fibres of connective tissue.

It is possible to draw innumerable analogies between tissues in our bodies and epitissues in our society, but many of them are not proper hierarchical homologies. The same valid or semi-valid pairings can be made between organs, built of interrelated tissues, and epiorgans. Muscle cells can be paired with laborers, farmers and soldiers; gland cells with merchants, manufacturers, cooks and housekeepers; epithelium with architects and engineers, builders and clothiers and with their products; white blood and reticulo-endothelial cells with doctors; red blood cells with postmen, handlers of trucks, trains and boats and with their implements; bone, cartilage and the simpler connective tissues with dams, bridges, roads and the men who build them; nerve fibres with clerks, stenographers, messengers and telephone operators; nerve cells with administrators, judges, politicians, priests; receptors with reporters and scientists and perhaps creative artists—these are some of the pairs of tissues and epitissues that suggest themselves.

Hierarchically homologous organs or organ-systems include, with some inevitable overlap with tissues: the skeleton, which may be compared with houses, roads, harbors and the civil engineers, architects and workers responsible for them; the skin and other protective systems with the military and penal bodies; muscles with farmer and labor groups; the circulatory system with all sorts of carriers and their producers and operators; the liver with grain elevators, merchandizing concerns, perhaps banking institutions; the reproductive system with the family and some aspects of other formative social groups and agencies, including school and church; endocrines with mechanical, electrical and other engineers, tool and machine manufacturers, perhaps publishers and advertising agencies; the nervous system with governmental bodies, aspects of schools and publishers, radio, motion picture and theatrical organizations; limbs and other structural regions of the body with cities and villages, etc. Certain body functions even are represented by concretized social organs—as memory and libraries, metabolism and banking, trading and manufacturing organizations.[5]

[5] One student of communication insists that the main functions of this are mutual approval and support. Homologous needs of the cells in a metazoan would be served by all the agencies of org integration, not only the one of transmission.

I am fully aware of the limitations of such pairings, indeed were the homologies too simple it would throw doubt on the value of the whole procedure. At least as great difficulties attend any similar attempt to homologize cellular and organismic components—as the nucleus with the reproductive system, cyclosis and diffusion with the circulation, the cell membrane with the skin, the genes and enzymes with the endocrines. The real focus of interest in the epiorganism, however, is not now in its units of various levels, but in the mechanisms which integrate them into an org.

The mechanical and spatial factors may be passed over—though physical crowding has molded our skyscrapers and our slums, and brute force still too often decides local action and national destiny. Transportative coordination has obviously undergone steady evolution in speed and efficiency and so made possible ever closer integration over ever greater areas. The sequence from horse or canoe to airplane and ocean clipper parallels and is in large part responsible for the evolution from nomad or frontier bands to world empires. Further, as the many-celled organism has stabilized and enriched the milieu of its cells and introduced new agents to strengthen transportative coordination, so the epiorganism makes available to its units a steady supply of food, water, heat, light—compare the regulated environment of the city dweller with that of a really self-dependent woodsman—and has introduced money and credit as new mechanisms for transportative integration.

Transmissive coordination in the epiorganism, communication, depends on the spread of ideas or symbols which are hierarchically homologous with nerve impulses. In poorly integrated forms the speed and distance of spread are low, mostly by conversation within earshot or the call to a distant person. Improved epiorgans have increased the rate and range through telephone, telegraph and radio, and, correspondingly, the strength of integration of the org.[6] Printed or written symbols—in newspapers, books, journals, letters—are somewhat anomalous in that they are transported as materials yet transmit ideas. Oddly, an exactly similar overlap occurs in the more elaborate organisms in which transmission is partly achieved by the liberation and diffusion of exciting chemicals —the neurohumeral substances.

But though the facilities for transmission, the nerve fibres of society, are indeed highly perfected, the impulses which travel along them leave much to be desired. The social nerve impulses, the symbols of language, when they achieve more of the all-or-none character of the organismic ones will convey less ambiguous meanings and lead to a more definitive stimulation and action of units. And a coordinating central nervous system hardly exists—true centralization of control is just coming into existence and a suprasegmental epicortex is a negligible rudiment. In terms of transmissive coordination and adaptive amplification, our best societies today are at the nerve-net stage of the jelly-fish or perhaps entering the ganglionated central-cord stage of the flat worm. A less pleasant comparison is invited when we take into consideration the high degree of specialization of other epiorgans, the efficient effectors and nerve fibres; for then our present society resembles a man of well-developed body and undeveloped mind, a powerful imbecile. Still some neuroid epiorgans do exist and help canalize and center transmission. Besides publishers, writers,

[6] My consultant points out that increased communication breaks down the local community differences and loyalties in favor of large-scale stereotypes. This is, of course, true for spatial groups, but very partially so for functional ones. Publications, meetings, etc., certainly help to reinforce the cohesion of professional, religious, industrial and other bodies.

performers and their vehicles, there exist the schools with their teachers and the churches with their ecclesiastics, the courts and other legal institutions and practitioners, the various agencies and personnel of government, the advertisers and propagandists. And underlying the activity of all these agencies are the crystallized or more amorphous behavior patterns, the laws and mores, laid down and set in the course of evolution, as are the fixed reflex patterns of the vertebrate segmental nervous system.

Gradients

But perhaps the most important coordinating mechanism in present day epiorganisms is the gradient, which acts in surprising detail like that in organisms. To be sure, the quantitative scale is not in such things as metabolic rate or mechanical power, as in the organism; nor are the units in a constant spatial sequence. Also, the mechanism of gradient operation is surely different in the two cases—though we know less about that in the multicellular body than about that in the social group. But the relation of dominance and subordination, of ascending control as a powerful agent in enforcing org unity, and determination of the differentiation of units for special org functions by this agent, are closely homologous in the organism and epiorganism.

The primitive example of gradient action is the family. The parents, usually the father, are dominant and the children are molded by them. Even here, very complex relationships between all the units—older and younger children, males and females, brighter or healthier and less favored—are known in detail and their influence on the individual's development is analyzed. With maturation of the subordinate units, the gradient breaks down and the small org largely or completely disintegrates, or else a new dominance is established by another unit, as when the oldest son assumes the father role. Entirely similar gradient relations exist in other less knit groups—the neighborhood group, especially children's play groups or gangs, social cliques and clubs—and depend on leadership by certain individuals. These are the sociologist's "primary" groups.

But far more elaborate gradients underlie many epiorgans and parts and are, indeed, the normal basis of the integration of most social institutions. Consider an army, a university, a labor union, a banking house, a department store, the Masonic Order, the National Government, the British peerage. In each case there is a clear hierarchy with successive levels of dominance and subordination, from general or president or director or king to private or clerk or common citizen. If the head units of such an org be lost, the next ones in the gradient commonly assume control and the missing parts are regenerated; if the most subordinate units are lost and not immediately replaceable from outside, those left at the low end of the gradient are "dedifferentiated" to take over the missing functions and regeneration is achieved. The fate of any single person, as of a particular flat worm cell, is influenced by his position in the gradient. On a still larger scale, especially in societies of old and stable tradition, a gradient of social classes and castes runs through the complete epiorganism, as the main antero-posterior one of the flat worm overshadows the many minor ones in organs and tissues which correspond to those in family or army. (See footnote 2, regarding the multiple forces acting on the cell, for comparison with the obviously multiple, and more or less conflicting, loyalties which act upon the social individual.)

The most important aspect of organism gradients is their ability to help determine morphogenesis, to direct the development of the initially totipotent cell

into one or another path of differentiation and specialization, and the same is true for the epiorganism gradients. Human units are also totipotential (except for rare pathological variants with severe mental or physical handicap) and differentiate in relation to their epiorganism. This, of course, is *not* to say that all men are created equal, that great mirage of primitive democracy, nor that any man could become an exceptionally good composer, marathon runner, or chess player. How effectively the unit performs its function depends largely on its inherited qualities; what function it performs, largely on its gradient and other org relations. Whether a child learns to speak English or Arabic is almost completely determined by the org of which it is a unit; the skill with which it uses that language, largely on its native talents.

All levels of fixity by birth and flexibility by situation exist, both in the determination of cells and of persons. The earlier in the history of the individual certain differentiations are established, the more profoundly different and unalterable the types they produce. Only for a brief period may any one cell differentiate either as liver or intestine; throughout life one sort of connective tissue cell can change into another. A child born into one caste is already restricted permanently to certain limited social roles; the same limitations are set by sex, different in matriarchal than in patriarchal societies; the structures of language and mores are set by family and similar groups in the early years; the further circumscriptions of general schooling, occupational training, etc., follow later and are progressively less irrevocable in their consequences. With longer functioning in any one role, however, redifferentiation becomes more difficult. An established doctor or merchant or machinist is unlikely to take up another's occupation.

Despite these factors making for fixity, the units can still respond to changed gradient conditions. The salesman or chemist or bookkeeper or teacher can take on the duties of administrator and gradually change his competence, his viewpoint, his interests, even his habits of life and dress under the quiet pressure of his new duties. Conversely, the adult, and particularly the child, excluded from normal gradient determination by relative lack of family attention and looseness of other group contacts, tends to develop non-adaptively. (The "anomie" of French sociologists.) Groups of such hoodlum children become epiorganism zooids, not subject to the ordinary social controls and causing conflict in the parent org. It is sound biology, as well as good social sentiment, to "clean up the breeding spots of vice"; and the method used when permitted by the wise settlement and social worker for doing this, strengthening the healthy organismic ties with acceptable play and occupational interests, is also sound.

Other epiorganism zooids form and maintain themselves. When spatially isolated, as in colonization, the daughter epiorganism may peacably go its own way and reduplicate more or less closely its parents. Or separation may be convulsive, by revolution, or incomplete, leaving a loose empire. Other zooids, spatially less isolated, may form on a larger scale than the hoodlum gang and the resulting major schisms lead to stress, usurpation, revolt and civil war. It is, in fact, in the relative feebleness of major gradients compared to the many lesser ones and in the poor integration of the org relative to the high differentiation of its units that the great crises of our society are rooted.

For one thing, the org forces which place units in the gradients, which select persons for leadership or subordinate positions, operate very poorly. Pearl has insisted that leadership is unique to mammalian groups, but the evidence of

Emerson refutes this for social insects. Not only is the queen the head of the colony gradient, but in sub-groups some one worker may persistently lead its fellows, largely, it is true, by physiological rather than psychological dominance. Conversely, even in vertebrates, the same goose does not always fly at the wedge point nor the same deer stand sentry for the herd. Yet is it true that leadership is more striking in mammals and man, and it becomes more a matter of superior mental abilities rather than one of greater physical strength as the group evolves. But it also becomes closely tied up with social as well as chromosome inheritance.

In one important point the body cell is not always hierarchically homologous with the social individual but sometimes rather with the single family tree. The most differentiated cells—brain, muscle, sense receptors—are coeval with the organism; each is formed in the embryo and persists as an individual throughout the life of the whole. Other cells—blood, skin, connective tissue—are more ephemeral, and successive units of like kind and from common stock give continuity to the tissue. In the epiorganism all units are short-lived relative to the whole, and even the most specialized functions are served by a succession of individuals. Often these come from a common stock or single family—indeed, the family tradition of doctors, craftsmen, even jailers, is still strong to-day though no longer supported by the secret knowledge passed on ceremonially from father to son. And, of course, the families composing the aristocracy, with or without formal titles of nobility, change very slowly except in new or metamorphosing epiorganisms.[7]

Units are, therefore, to a greater or lesser extent born into certain gradient positions. In so far as membership in a particular family insures certain capacities, inherited via chromosomes and early training, this is as sound as having the same epithelial cell stock continue to provide the epidermis. In so far as nature and nurture of the individual are independent of family membership, succession based upon descent destroys the gradient of ability and leadership. Of course, some intermediate condition actually exists. The children of the banker and those of his cobbler will show, on the average, little consistent difference in endowment, a significant one in training (though many social case histories leave much doubt that the "privileged" child has the best of it), and a still greater one in final gradient level; but in individual cases the shoemaker's son will dominate the banker's. I doubt that anything would more effectively advance our epiorganisms of to-day than improved placing of units in gradients at their proper quantitative level. This will be ever more

[7] I omit consideration of the problem of aging in the epiorganism, though here also interesting parallels with the organism can be drawn. An old org is composed of units of a greater average age; and just as some cells in advanced metazoans have come to endure as units for a relatively long time, so also is longevity of the individual in the epiorganism increasing. Life expectancy at birth has almost tripled during the two millennia from the Roman Empire to that of Britain. Old men, as old cells, are less hospitable to the new and changing, and the org they come to constitute is ever slower with innovation. Conversely, with long-lived units there is a correspondingly prolonged period of immaturity. The nerve cells of the human brain continue to multiply for a few years after birth and man, the longest lived mammal, has by far the longest period of formative immaturity. The long childhood and youth, in turn, have favored strong family relationships and so the development of society. It is hardly surprising that social growth, for example the period of formal schooling, is also becoming prolonged, and, as our society endures, that ever older men are found in the positions of dominance.

A further point that will not be pursued is that the epiorganism is based upon sexual reproduction, through the family, just as the multicellular organism is based upon the asexual reproduction of cells. Mitosis is thus seen again as a precursor and partial homologue of sexual reproduction.

possible as measures of individual capacities and achievements are developed and applied. Present difficulties would diminish further if the great discrepancies which exist in the social rewards for function performed at different levels were lessened. This raises the question of the intensity of the forces of integration within an org, seen in a society in terms of power and freedom.

Power and integration increase together. The well-integrated animorg captures more substance and energy from its surroundings than does a poorly integrated one; and the rise in physical power resources tapped by present epiorganisms—coal, gas, oil, water, and possibly soon atomic energy—has been prodigious. Greater energy supplies and more specialized and organized epitissues and organs in turn greatly augment the intensity of intraorg forces and the power of the society over its members. Transport of materials and communication of ideas, changing from camel-back to air-express and from vagrant gossip to national radio hook-up, make the difference between nomad, self-sufficient Arab bands — constituting an epiorganism hardly at the sponge stage of integration—and sessile, internally and externally interdependent English citizens, an epiorganism approaching the integration of a flat worm. In fact, these newer social structures are rapidly bringing into existence still more integrated orgs, the totalitarian states, with still greater power over their units—by propaganda and censorship—and the discrepancy between magnitude of power and control of its use by poorly selected dominant units is becoming intolerable.

Freedom

The picture is commonly painted of ever more ant-like human societies with the individual reduced to a helpless slave of the group, lacking initiative, swathed in restrictions and altogether a sorry case. That social control will increase, I am certain; but that an abject citizenry *must* result, I can not agree. I have already pointed out that freedom implies conformity rather than license. The org must modify the action of its units, but restrictions are balanced by new opportunities. As integration evolves, certain types of behavior are forbidden but others are created or made possible. If we, in present society, are not "free" to go naked in the summer, neither were the Indians "free" to turn on steam heat in the winter. We are not free to use the table manners of Henry VIII, nor was he to use a fork. We must learn to read and write; the peasant of yesterday had not this privilege. We may not kill, but radio, movies, books, even food packages with mystery serials, help us sublimate our aggressions. It is rather like wandering on through the countryside—each fork of the road calls for renunciation of one alternative but leads to two new ones.

And, note, of the controls and checks to which we submit we are mostly quite unconscious. We are molded by the epiorganism and run free before its forces. Indeed, we gladly conform to the great majority which we do recognize, for they operate through tradition rather than law and we accept that tradition. Do we go without clothes or eat with our fingers in the sanctuary of our own homes? Our women do not feel thwarted and unsuccessful because they are not expected to compete for money and prominence; while men, in our society, feel inferior when not supporting their families. But in matriarchal groups the reverse roles are as unquestioningly accepted. Men born into a caste, apprenticed into a guild, trained in a craft are proud to do their jobs well and do not feel forlorn at the impossibility of becoming king. The relative fluidity of our own early culture and the "freedom" that American youth has to "rise to the top" has certainly produced little contentment—

European visitors and local psychiatrists are impressed with the restless striving which is almost a national psychosis.

No, it is possible for men to be part of a highly integrated society and yet feel, as individuals, more free, actually to have more avenues open for satisfying self-expression, than when they are epiorganisms of their own, like single-celled organisms. Which of us would exchange our present state for the privilege of roaming the woods naked and unarmed, without language or fire? But this will be true only as the society evolves along the lines of gradient and other control and is solidly based on the cooperation of its members. A set of regulations imposed by a few usurpers of power, dictatorship of the current stamp, sits ill and is not long tolerated. The control of the org by its units can not be arbitrarily abolished; the head is the dominant end of the gradient but not independent of it. Neither prohibition nor clean sidewalks and parks can be forced upon the average American citizen of to-day. But mores change more rapidly than they used to, under the impact of mass propaganda, and social attitudes can be manipulated.

Another word is needed on the matter of conflict between individual and social interests, of free or fettered behavior. We have seen that cooperation of units in an org has survival value at cell and organism levels; it has regularly been preserved in evolutionary change. This is no less true at the epiorganism level—cooperative groups, from bands of prehistoric man on, have survived or overcome their more factional contemporaries. And the unit mainly performs his altruistic actions not by external but by internal compulsion, because of loyalties that are part of himself rather than of laws imposed upon him. True, the growth of personal affections and loyalties and of conscience (or, in Freud's terminology, part of the ego and the super-ego) is conditioned by the group—but so is his very ability to think at the symbolic level of language. And some altruism is certainly very old in vertebrate life—many animal, as well as human, mothers will defend their young with their own lives, and this self-sacrifice may extend between other members of the family group. But a carry-over to larger org groups occurs only under such org influences for they demand greater abstraction. Yet even dogs, under the influence of human groups, perform many acts which show every sign of abstract loyalty; and football heroes play on despite the pain of broken ribs for the glory of old Eli, abolitionists risked much in running the "underground railway" from an abstract loyalty to humanity; loyalties are very real to vocational, religious, local and other groups; and when a country is actually attacked few indeed of its members are not genuinely willing to fight and, if need be, die. In fact, however "low" the "morals" of the state, seen in terms of the self-interest of some controlling man or group, the mass of people give it loyalty because of an appeal to their humanitarianism rather than to their selfish interests.

IS OURS THE "AGE OF INSECTS"?

By Professor CHARLES T. BRUES

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In popular treatises dealing with organic evolution and in accounts of the geological history of life in our planet, it is customary to denote certain periods by reference to dominant groups of animals or plants. Thus, in relation to animals, the Devonian becomes the "Age of Fishes;" the Mesozoic, the "Age of Reptiles," and the Tertiary, the "Age of Mammals." Similarly, botanists have other catch-phrases, but in the true spirit of self-admiration we are all generally agreed that the Quaternary is the "Age of Man." In this rather inexact terminology these periods represent the rise of the several types of animals to widespread abundance, extensive speciation and world dominance. As the phenomena are successive, each type has later been replaced, or will be in the future if organic evolution proceeds as we know it has in the past.

Even in our own case, reference to the Holy Scriptures will reveal the fact that the fall of man has already transpired and that according to the diligent researches of Bishop Ussher this is exactly 5,933 years past at the present moment. Aware of this incident in the Garden of Eden, entomologists have proclaimed recently that we are now really in the "Age of Insects," and that man, already a back-number, must stage a fight for his life with the insects. This has demanded the stationing of economic entomologists in the trenches or in air squadrons to shower the enemy with poison dust and thus make the world safe for agriculture and permit unrestrained multiplication within the human species.

There is, of course, a modicum of truth in all this. From a purely anthropocentric view-point it is perfectly logical to regard the menacing spread and increase of a few highly destructive insects as an "Age of Insects," and the latter would mean just another monkey wrench in the machinery of human progress.

However, it is far from my intention to deal with our present world, but to revert a few centuries to the Age of Man, the animal, when he was still unhampered by the newer age of machinery or gadgetry that has served him lately to muddle the destiny of the whole living world, including his own precious human brethren. From the standpoint of the biologist, who believes, or at least ought to believe, that all organisms have their place under the sun, it is still an interesting though more academic question to ascertain whether insects are still in their ascendency.

How may we recognize the heyday of the insects or of any other group of animals? For an answer to this question we must rely upon an examination of their characteristics at the present time in comparison with the meager information so far accumulated concerning their past, with perhaps some dubious predictions as to what Nature may hold in store for them in the future.

There appear to be several partially independent lines of approach that involve matters which we know have been concerned in the rise of groups like the reptiles and mammals. These two are to be mentioned particularly, since we have unusually full information relating to their actual evolutionary history. We shall have to distinguish three phases which are successive and continuous in every respect. In the first, the group of animals is still on the upgrade in the struggle for existence and augmenting

the pressure that it exerts upon the living environment; in the second it has attained the peak or heyday of its development; in the third it has passed its prime to enter a period of senescence or decadence, mainly contingent upon the rise of competing groups. Such a sequence seems to be inevitable among organisms and it has been repeated many times. In which phase a group falls may not readily be stated in dogmatic terms except in cases where we have historical knowledge that includes all three stages. For some groups this is available, notably for the reptiles, brachiopods, xiphosurans and many others, but if the third stage can not be demonstrated we must rely upon more questionable evidence to distinguish between an increasing or a static condition of dominance. We are obviously in this dilemma concerning the insects, for entomologists are not wont to admit that these animals form a decadent group, although it has been made clear that the more primitive orders have long ago declined in competition with the more highly specialized ones, namely, those which undergo a complete metamorphosis during ontogeny. The insects as a whole are nevertheless universally regarded as in the prime of their evolutionary ascendency, forming, as they do, the dominant series of invertebrate animals. On this account our present era has been termed the "Age of Insects," quite aside from their economic status in relation to human activities.

It is with this statement that I feel obliged to differ at the present time, as it does not appear to be justified in the light of present knowledge.

The relevant sources of information may be grouped roughly as follows in several categories, each in a sequence with reference to time: Abundance; extension or reduction of range. Diversity; speciation; specialization in structure, development and behavior. Size of individuals.

Contributory factors, such as fecundity, food-supply and susceptibility to parasites, are not easily evaluated in dealing with extinct faunas. Furthermore, we can not disregard the predestined orthogenetic tendencies among animals that are a characteristic of evolutionary progress, even though these are in disrepute among many genetical biologists.[1]

With regard to these sources of information the insects may be examined with some degree of exactness during at least a part of their history. There are naturally wide and serious gaps in the sequence, but I believe that we now have in hand sufficient data to warrant a rather definite statement that insects as a whole have reached the peak of their development and that their period of decadence has already set in. As usual with systems involving man, nothing in the future is predictable on the basis of analogy, even though his influence should pass out of the picture, for the expectancy of all other forms of life in a future

[1] This statement may be questioned as not universally true. For example, the late Professor E. M. East recognized the difficulty of reconciling the phenomena of determinate evolution as accepted by paleontologists with the genetic interpretations of gene mutations and dominance in experimental animals and plants. One of his last publications contains a consideration of defective and non-defective mutations, together with a statement of these difficulties and the bearing of the slight, non-defective type of mutations upon evolutionary theory. East's discussion is not developed specifically in relation to orthogenesis, but the possibility of its application thereto is obvious. Attention is called to this paper partly in justification of my own remarks, but more particularly as its title "Genetic Reactions in Nicotiana" (*Genetics*, 20: 443–451, 1935; later summarized in part in *The American Naturalist*, 70: 143–158, 1936) gives no hint of the broad scope of its contents. These deserve wider notice and consideration by biologists, as they may serve to bring together such divergent views on evolution and speciation as those voiced recently by Reusch (*Biological Reviews*, 14: 180–222, 1939) and Muller (*ibid.*, 70: 261–289), neither of whom refers to East's papers.

world has already been irrevocably altered by our own brief and disturbing presence. It is clear therefore that it is useless to peer into the future of any series of animals.

The basis of all knowledge of the past history of animals must rest on the recovery of their fossil remains, and it is well-nigh impossible to reach any statistically valid conclusions concerning abundance at any particular time. Fossilization depends upon the chance combination of physical, chemical and ecological factors, and recovery of such material depends likewise clearly on chance. Moreover, insects are small, less readily recoverable than larger animals and not so easily reconstructed from fragments. There is, however, very fortunately a happy combination of circumstances which resulted in the preservation of innumerable Tertiary insects in Baltic amber that permits a most concise study of the insect fauna of the lower Oligocene. It is from these amber insects that I wish to draw much of the material data now to be presented. Experiments conducted by the writer (*American Naturalist*, 67: 385–406, 1933) enable us to indicate what part of an insect fauna we may expect to trap in the sticky resin exuding from trees, and this is the very way that insects were caught in the Oligocene resin which has now hardened into the amber within which they are permanently preserved. From a census of insects caught in a forest by means of tanglefoot we find that there is a selection of smaller species, as the larger ones are better able to drag themselves loose; consequently, we can discount the consistently small size of the preserved amber insects. In the paper just referred to I have dealt at far greater length than is here feasible with the comparative abundance of insects in general in amber and in the modern forest, reaching the conclusion that they were certainly no less numerous in the amber forest. It is evident that there is a difference in the numerical representation of several orders in the two faunas, and that what we may definitely consider to be the more primitive ones were proportionately more abundant in the amber fauna than in the recent one. This is true of the Coleoptera and Diptera, both modern orders with complete metamorphosis. The former are undoubtedly an older, more generalized group than the Diptera, which are morphologically the most specialized of all insects. They have become much more numerous, while Coleoptera have dwindled greatly since the early Tertiary. Two other orders, Lepidoptera and Hemiptera, show a notable increase, and three, Thysanura, Collembola and Trichoptera, have suffered a conspicuous loss in numbers during the same period.[2] It will be noted that the present-day preponderance of holometabolous insects that has replaced the very abundant Hemimetabola of the late Paleozoic served to change entirely the complexion of the insect world during the Mesozoic. This occurred undoubtedly during the earlier part of the Mesozoic. Direct evidence on this point is not so complete as might be desired due to a great dearth of known cretaceous insects. It is incontrovertible, however, that many of the more specialized types of higher insects were evolved and greatly diversified long before the dawn of Tertiary times.

A continuation of this trend during the Tertiary has resulted not only in a greater prevalence of forms with complete metamorphosis, but in a selective change among these orders. An example of this is an increase of Lepidoptera coincident with a diminution of their obvious precursors, the Trichoptera. Thus, although the status of individual orders shows notable and quite consistent changes, it conforms readily with

[2] The supporting data for these statements are included in my earlier paper cited above.

what we should expect from the progressive differentiation and specialization of families and smaller taxonomic units. Aside from these changes there is no reason to believe that insects have increased in abundance during the late Tertiary or Quaternary.

As to extension or reduction of range during this period it is very difficult to secure positive data, as the amber and other Tertiary insect remains represent only isolated faunas. Nevertheless, there are cases like the occurrence of tsetse-flies, now restricted to Africa, in the Miocene of North America and the appearance in Baltic amber of genera of ants now persisting only in parts of the Austromalayan region. To these might be added many other examples of similar nature, but individually more open to question since the present distribution of many of the less conspicuous groups of insects is far from completely known. In the aggregate, however, there is much evidence in support of the belief that certain types now still numerous in restricted areas enjoyed far wider range during the Tertiary.

With relation to diversity and speciation, the amber insects supply us with more extensive and concise information. These have been studied with care in only a few groups, as it is a slow and tedious process to examine them minutely, but the amber fossils are so perfect that their taxonomic relationships may be determined almost as completely as those of living species. I shall refer to only two groups which are personally familiar to me in both the living and amber faunas.

One of these is the family Phoridae, highly specialized Diptera that form a compact group, quite sharply distinguished from their relatives by good morphological characters. There are well over 1,000 described living species distributed in about 100 genera, one of which (Megaselia) includes fully half the known species. The amber fauna is known to contain at least thirteen species distributed in ten genera, but only two species belong to Megaselia, and four of the genera are now extinct so far as our knowledge extends.[3] As might be expected, the four Oligocene genera are more primitive in that they are to some extent intermediate between the three living subfamilies, but each shows also some highly specialized character that is either unique or repeated only in some aberrant living genus. There are among the amber species also highly differentiated forms obviously ancestral to living forms. One of these, Protoplatyphora, is very similar to the recent Aenigmatias, but clearly more generalized. The living genus is remarkable in having greatly degenerate wingless females living only in ant-nests. Only males are known from amber, but these are abundant and there seems to be no escape from the conclusion that these flies were not only myrmecophilous at that time, but that apterous females had put in their appearance and being subterranean in habits did not find their way into the amber. The living species occur with Formica, which was a dominant genus of ants during the Oligocene of Europe just as it is in the recent holarctic fauna. That these ants were as perfectly attuned to their environment then as now is attested by the persistence of the most abundant ant of the Baltic amber, *Formica flori*, to the present day with such very minor changes that its living representatives (*Formica fusca*) are scarcely distinguishable as a separate species. Moreover, *fusca* is still the dominant member of its genus in the holarctic region, although a great sufferer from various parasitic enemies, to which it has fallen prey during its long exposure to such dangers. With the

[3] These are considered in detail in my recent "Fossil Phoridæ in Baltic Amber"; *Bull. Mus. Comp. Zool.*, Harvard, Vol. 85, pp. 413–436, 7 figs. (1939).

ants as with the Phoridae just mentioned, the amber fauna shows also the presence of species with some of the highly specialized developments of modern ants. Thus, as the late Professor Wheeler has pointed out in his study of the amber ants, a dimorphic worker caste was already present in several genera, and in one genus, Erebomyrma, it even appears probable that the large, soldier form of worker had been developed and subsequently lost before the Oligocene.

Great specificity in food-habits is an outstanding characteristic of living insects equally prevalent among vegetarian, predatory and parasitic types. It can not be doubted that the origin of many of these specialized dietaries must be traced back to the lower Tertiary, since when we examine them in the light of distribution and taxonomy, it is clear that they have persisted over periods of time long enough to permit extensive speciation and great geographical movements. Specificity of food relations involves the persistence of instincts, and for this reason we must admit that the phases of instinctive behavior here concerned are likewise of equally long standing.[4]

It must be noted, however, that practically all herbaceous plants are quite generally believed to be of very recent geological origin, probably not more ancient than the Pliocene. If this be true we are faced with apparently insurmountable difficulties in understanding the present extended geographical range of many genera and other taxonomic groups of higher plants. Certainly, also, the food restrictions among certain groups of vegetarian insects speak for long associations between them and their food-plants. For these reasons one is led to believe that the apparently late appearance of these herbaceous forms may be one of the vagaries of nature in her preservation of fossils, similar to many others that block the path of paleontological research.

From almost every point of view the several groups of insects that develop as entomophagous parasites outrank the other members of their class in the extent of their specializations. They are also very numerous and give evidence of being a recent product of insect evolution. Consequently, it should be illuminating to look at these in the light of the Baltic amber fauna. The largest series with habits of this sort is composed of a number of related families of Hymenoptera. These parasitic Hymenoptera are abundant in the Baltic amber, and a considerable part of them have been studied.[5]

If we expect to find these canny creatures represented by drab and dumbbell ancestors in the Oligocene, we are doomed to disappointment. They are neither dowdy in appearance nor Victorian in manners, but are readily mistaken for prevue models of 1940. In diversity, speciation and structural specialization they are in no way inferior to the living members of their respective families, and a number of the most bizarre developments in recent genera are already known to have their counterparts in the Baltic amber fauna.

Here, as with the Phoridae and ants mentioned previously, the amber fauna is primitive in that it includes one extinct family, Pelecinopteridae, more or less intermediate between two living ones and because several of the more primitive families are better represented there than in the living fauna.

[4] I have recently summarized some of the matters pertinent to the persistence of instincts among insects in "Food, Drink and Evolution," *Science*, 90: 145–149, 1939.

[5] The writer has published a general account of these as "The Parasitic Hymenoptera of the Baltic Amber, Part 1" (Bernstein Forschungen, Heft 3, pp. 4–179, 1933). This and further unpublished parts have supplied the data on which the following paragraphs are based.

When we examine the genera more in detail, however, the abundance of highly modified types is surprising. In several families there are living genera that have the body greatly flattened much after the fashion of many insects that live beneath the bark of logs. Such forms had quite reached their present remarkable form in the Oligocene, as the amber contains the precursors of these strange types in at least three independent instances.[6]

The females of many of these parasitic Hymenoptera are provided with a greatly lengthened stylet-like ovipositor which enables them to insert their minute eggs into the host, often through intervening plant tissue. In the ichneumon-flies the ovipositor is not retractile and must be trailed about like a miniature strand of tenuous spaghetti, but in other forms it may be withdrawn within the body like a sting and concealed when not in action. In some Scelionidae there appears at the base of the abdomen a dorsal protuberance which becomes so greatly elongated in several genera that it protrudes as a hollow horn, curving upward over the thorax to form a scabbard into which the basal portion of the ovipositor is withdrawn. This handy little affair permits the development of an ovipositor much longer than the abdomen, yet completely retractile. Contrary to expectations, this structure is not new, but has its counterpart likewise in the scelionid fauna of the amber. Many similar examples relating to other structures might be cited.

There remains the question of individual size. This might seem quite inconsequential were it not for the fact that the rise of certain other groups of animals has been so definitely associated with an increase in bulk of the individual organisms, leading often to giantism with its implications of metabolic and ecological unbalance. The exact nature of such resulting maladjustments is frequently open to question, but the fact remains. Among insects the restriction of stature is usually admitted to depend upon physical phenomena attending the periodic molting of the external skeleton during growth and upon a spatial limitation of the respiratory function inherent in the structure of the insect's tracheal system. We do know, however, that insects much larger than any now living once existed and that their average size at all times has been far below any limit that might be fixed by physiological requirements. Nevertheless, it can not be said that there has been any consistent change of size in comparable groups since the earliest known Paleozoic forms of insect life appeared.[7] As we have already noted, one can detect no changes during the course of the Tertiary, and here we have a very large assemblage of known forms on which to base our conclusions.

It seems reasonable, therefore, to discount the dire prediction that insects are at the present time threatening to engulf the more modestly expanded groups of animals that now share the world with them.

The more immediate practical menace of insects to agriculture is of course another story. Here we can only apply to ourselves the threadbare allegations of propagandists that clog the short-wave radio: "You are the source of the trouble and you must bear the consequences."

[6] These are Platyscelio and Platytelenomus, members of the subfamilies Scelioninae and Telenominae, respectively, in the family Scelionidae and Palaeobethylus in the family Bethylidae. The latter is abundant in the amber and is represented by three species.

[7] A detailed consideration of the trend of insect stature throughout the geological history of the group is included in Professor F. M. Carpenter's "A Review of Our Present Knowledge of the Geological History of the Insects," *Psyche*, 37: 15–34, 1931.

THE TULAROSA MALPAIS

By Professor LEE R. DICE

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In the Tularosa Basin of southern New Mexico lies a large bed of black lava, the Tularosa Malpais. The local name "Malpais" (pronounced mal′-pī) is evidently a modification of the Spanish words *mal pais*, meaning a bad place. The Malpais truly is a bad place for any one attempting to cross it with a horse; even to a man on foot, travel over the broken lava is extremely difficult. Several automobile roads, however, have been built across the lava bed, by which it may now be crossed with ease. For the tourist who may wish to visit the Malpais, accommodations can be obtained at Carrizozo or at other nearby towns.

The time of extrusion of the lava making up the Tularosa Malpais could not have been more than a few thousand years ago at the most, for the lava rocks are still sharp and hard, with little evidence of the weathering which quickly dulls the sharp edges of exposed rocks.

Just northwest of the fresh-looking lava of the Malpais is a smaller bed of much older lava, greatly weathered and almost obscured by the vegetation which covers it. There have been, therefore, at least two periods of volcanic activity in the area.

The volcanic cone from which at least part of the newer Malpais lava was extruded is still visible a few miles northwest of Carrizozo. The cone, however, is low and flat, rising only about 200 feet above the general surface of the lava flow. From this crater, and perhaps from others now concealed under the lava, the molten rock flowed southward down the gentle slope of the desert plain to a point about 13 miles southwest of Three Rivers. The total length of the laval flow is about 44 miles. At no place, however, is it wider than five and one half miles, and where hemmed in by hills it is much narrower. Its total area is about 120 square miles.

The lava must have been very hot liquid when it was poured out from the volcanic crater, for it has not piled up into large masses at any place, but has spread rather thinly over the plain. At its edges, where it stopped in cooling, the lava rises usually about 10 to 20 feet above the desert sands, but in some places as much as 50 feet. In the middle of its stream the lava must be thicker, especially where it has filled some ancient desert wash or other depression, and the small hills that lay in the path of the liquid lava were surrounded and left as islands which still rise above the sea of black rock.

The surface of the lava is broken by great cracks and crevices, running in every direction. Beneath the surface there are many large caverns, the roofs of some of which have collapsed and left great depressions filled with broken rock. It is this broken surface of the lava sheet which makes it so difficult for large mammals to traverse it. On the other hand, the abundance of caves and crevices makes the Malpais an ideal home for many kinds of small animals.

No springs nor streams of water occur on the Malpais lava itself, although it is said that one can hear, deep down in some of the larger crevices, the gurgling of running water. At the southern end of the Malpais, however, there occurs a large spring, called Malpais Spring, the water from which as it enters its large pool is clear and very cold. This spring would be a godsend in the desert where it occurs if it were not for the fact that it, like

MAP OF SOUTHERN NEW MEXICO
SHOWING LOCATION OF THE TULAROSA MALPAIS.

many other desert springs, is heavily saturated with alkali. In fact, the water of Malpais Spring is so heavily filled with common salt, gypsum, epsom salts and other minerals that a man suffering from thirst and drinking the water would likely die as quickly from the effects of the dissolved alkali as he would from lack of water.

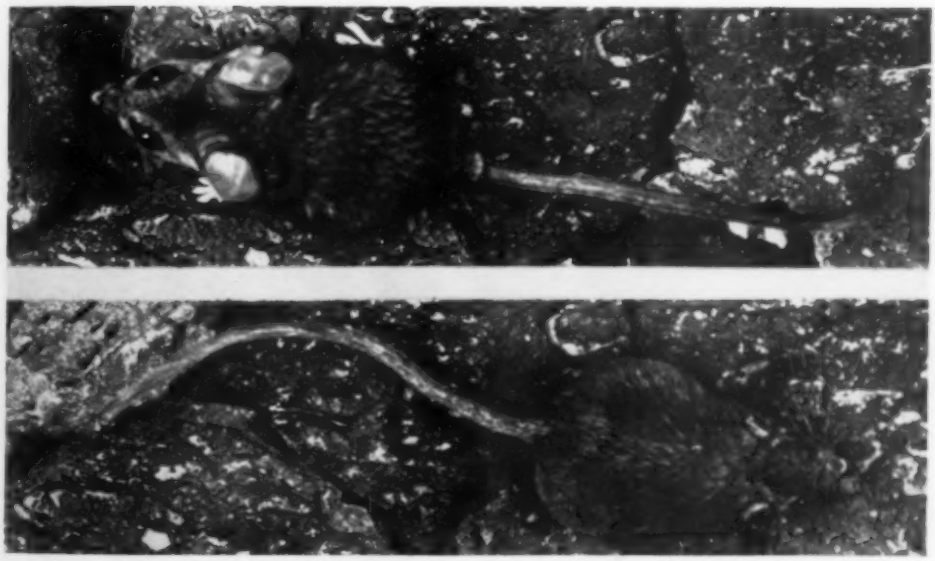
In spite of the heavy saturation of various salts in the water of Malpais Spring, a large number of small fish live in the pool formed by the spring and in the small stream which flows from it for a few hundred feet before it is lost in the desert sands. These fish are all of one species, identified by Dr. Carl L. Hubbs as a peculiar member of the genus Cyprinodon. Closely related species of fish are widely distributed in isolated springs and streams in the southwestern deserts, all of which are presumed to have descended from marine forms, some relatives of which are still living in the Gulf of Mexico.

A scanty growth of vegetation occurs on the Malpais lava, in spite of the inhospitality of the habitat. From each crack in the rock where a tiny bit of soil has accumulated there protrudes a tuft of grass, a cactus or some other plant. It is remarkable that any plant can endure such a situation, for the rainfall is exceedingly scanty, and long periods in summer may pass with no precipitation at all. Moreover, there are drying winds and the heat of the summer sun is intense. The black lava rocks absorb so much heat that they become very hot, so hot in fact that one can not bear to hold one's hand on them. These black rocks retain heat so well that when they have become deeply heated, they are still distinctly warm to the touch in the morning after having radiated all night. Evidently any animal or plant which is able to live in such an environment must have special adaptations to enable it to endure drought and heat.

At its upper end, near Carrizozo, the Malpais is over 1,200 feet higher in elevation than its lower end at Malpais Spring. There is accordingly an important difference between the climate of the upper and the lower parts of the lava flow. At its lower end, the Malpais lies in the desert belt, and its characteristic plants are those of the desert, including mesquite, creosote bush and various kinds of cactus. At its upper end, the Malpais lies in an arid grassland area near the lower edge of the juniper-pinyon belt. Here grasses grow sparsely on the rocks, a few junipers occur, and there is an open growth of such plants as the sotol (Dasylirion), Spanish bayonet and a few types of cactus.

Small mammals living on the Malpais have very dark-colored coats, no less than six species showing a tendency toward dark pelage colors. Of these species, the rock pocket-mouse (*Perognathus inter-*

ABUNDANT CAVES AND CREVICES
IN WHICH SMALL MAMMALS MAY MAKE THEIR HOMES.



JUNIPER-MOUSE AND ROCK POCKET-MOUSE IN CAPTIVITY
BELONGING TO A DARK-COLORED RACE, AND RESTRICTED TO THE TULAROSA MALPAIS. SEEN HERE ON THE BLACK LAVA ROCKS OF THEIR HABITAT.

VARIED VIEWS ON THE TULAROSA MALPAIS

UPPER LEFT: GRASSES AND OTHER PLANTS GROWING FROM TINY CRACKS IN THE ALMOST BARE ROCKS. UPPER RIGHT: SHARP LAVA ROCKS, SHOWING LITTLE TRACE OF WEATHERING. LOWER LEFT: MOLTEN ROCK FLOWING FROM THE SMALL CRATER IN THE DISTANCE AND FROM PERHAPS OTHER CRATERS NOW BURIED BENEATH THE LAVA, COVERED AN AREA OF OVER ONE HUNDRED SQUARE MILES. LOWER RIGHT: ON THE TULAROSA MALPAIS FIVE SPECIES OF RODENTS HAVE DEVELOPED DARK-COLORED RACES, ALL OF WHICH ARE RESTRICTED TO THIS BED OF BLACK LAVA.

medius), the rock-squirrel (*Citellus variegatus*), the juniper-mouse (*Peromyscus nasutus*), the white-throated woodrat (*Neotoma albigula*) and the Mexican woodrat (*Neotoma mexicana*) have developed dark-colored races. Some of the cactus-mice (*Peromyscus eremicus*) living on the lava are also dark in color, but many of them are no darker than individuals of the same species living on the pale-colored rocks of the adjacent mountains. Possibly the trend shown by the occurrence of some dark-colored cactus-mice on the Malpais will eventually result in the formation there of a dark-colored race of cactus-mouse also.

IRREGULAR EDGE OF THE MALPAIS

THE SMALL HILLS LYING IN THE PATH OF THE LAVA WERE SURROUNDED AND LEFT AS ISLANDS.

It is noteworthy that all the kinds of small Malpais mammals which are blackish in pelage color are those which are confined to rocky habitats. These are the species listed above. On the other hand, the species which occur both on the Malpais and on the surrounding pale-colored desert sands are of normal pale color, as they are in other parts of the southwestern arid regions. This applies to the cottontail rabbit, to the jackrabbit, to the coyote and to numerous other wide-ranging species. Evidently isolation has played a considerable part in the formation of the dark-colored races of small mammals which occur on this lava bed.

The reason that dark-colored races of small mammals occur on this and on other beds of black lava in the southwestern deserts is, however, not certainly known. The most reasonable explanation so far suggested is that pale-colored animals, being very conspicuous on black rocks, would therefore tend to be captured by predators, while the darker-colored individuals would tend to be preserved. Dark-colored races would thus in time be built up on dark-colored habitats by natural selection.

It is an interesting fact that the Tularosa Malpais at its southern end lies only a few miles from the nearest edge

THE TULAROSA MALPAIS

AN EXTENSIVE BED OF VERY DARK-COLORED LAVA ROCK IN SOUTHERN NEW MEXICO.

of the White Sands, which lie in the same desert basin and at the same elevation. As is well known, on the White Sands there is found a nearly white pocket-mouse (*Perognathus apache gypsi*), which in color tends to match the white gypsum soil of its habitat. None of the pale-colored gypsum pocket-mice have ever been taken except on these pale-colored sands, just as none of the dark-colored Malpais mammals have even been taken elsewhere than on the black lava.

A considerable part of the White Sands are now in government ownership as a National Monument. Under the protection of the National Park Service these sands can be expected to retain their peculiar flora and fauna indefinitely, but unfortunately, no part of the Tularosa Malpais is under protection. Goats are now being pastured on at least part of the lava bed, and unless protection is given soon to the area it is likely that irremediable harm to the native plants and animals will result. In this rigorous desert habitat it takes years for many kinds of plants to grow to flowering age, but a herd of goats can in a single day destroy all the more delicate herbs and shrubs growing on a number of acres.

The Tularosa Malpais is unique in the number of dark-colored races of small mammals which inhabit it; its flora, although as yet little studied, shows many adaptations to extreme aridity; and to one with geological inclinations the lava bed itself is full of interest. Although suggestions have been made in the past that this lava bed be placed under the protection of the National Park Service, no formal plan is now under consideration. No serious objection to making the Malpais into a National Monument, however, is likely to be made by the local agricultural interests, for the forage available on the lava, even for goats, is almost negligible.

LIFE AND HABITS OF FIELD MICE

By Dr. W. J. HAMILTON, JR.
DEPARTMENT OF ZOOLOGY, CORNELL UNIVERSITY

SHORT-TAILED, beady-eyed field mice (Microtus) are found in suitable waste lands throughout the temperate zones of the Northern Hemisphere. Nearly one hundred species and their races occur in North America. Although these microtines are of tremendous economic significance, the habits of most species are very little known. Sadly enough, this is true of most of our small native mammals, for naturalists seem to delight in the rare or unusual and seldom direct their attention to the commonplace. It is difficult to imagine why field mice have been so neglected. Surely there is no lack of material for the investigator. The communal habits and social life of these voles should intrigue the student of animal behavior; their extraordinary reproductive potential and cycles must eventually attract those interested in animal populations, while the pandemics which periodically beset these populations afford a fertile subject for the epidemiologist.

HABITS OF FIELD MICE

Perhaps no other small mammal is so adaptable in its selection of a habitat in which to seek its food and rear its young. Meadow mice swarm on the salt marshes, crowding to the very edge of the beach and taking refuge on floating jetsam when high tides flood their home. The species occurs sparingly in dense woods in company with the shrews and big-eared deer mice, or inhabits the prairies of the Mid-west. Field mice occur from sea-level to near timber line. These mice are most at home in the lush meadows, where the damp earth gives rise to a dense vegetation of grasses and low succulent annuals, or in fields which support a canopy of dead grasses to shield them from the prying eyes of watchful hawks. Even within the limits of the great metropolis, a vacant lot grown to weeds and grasses will support its quota of mice, if vagrant cats are not too numerous and efficient. Lift a fallen sign board and you will see the little creatures running from their bulky grass nest to the shelter of the surrounding vegetation.

Any one who has walked the fields and meadows has seen the little globular or slightly flattened nests of these ubiquitous creatures. As the winter snows melt back, these shelters are left exposed and lie directly upon the surface, for it is a curious fact that mice build their nests on the surface of the ground during the winter months, and often tunnel below the ground to construct their shelters with the approach of warm weather. The nests are prepared quickly, a few hours often sufficing, but withal, they are sturdily built. The mouse gathers in its sharp teeth dried grasses near at hand, and weaves these into a compact ball, interlacing the stems and blades so firmly that the interior is quite waterproof. Ordinarily each nest is occupied by a single animal. From the soft interior, lined with finely shredded grass, one or more openings lead to the surface paths or to subterranean burrows. The mice are cleanly little animals about their homes, and if the nest becomes soiled it is quickly deserted and a new one constructed.

Part the dead matted grass and a new world is revealed. Little paths, scarce the width of a garden hose, crisscross one another to form a labyrinth of mouse highways. These little paths are made

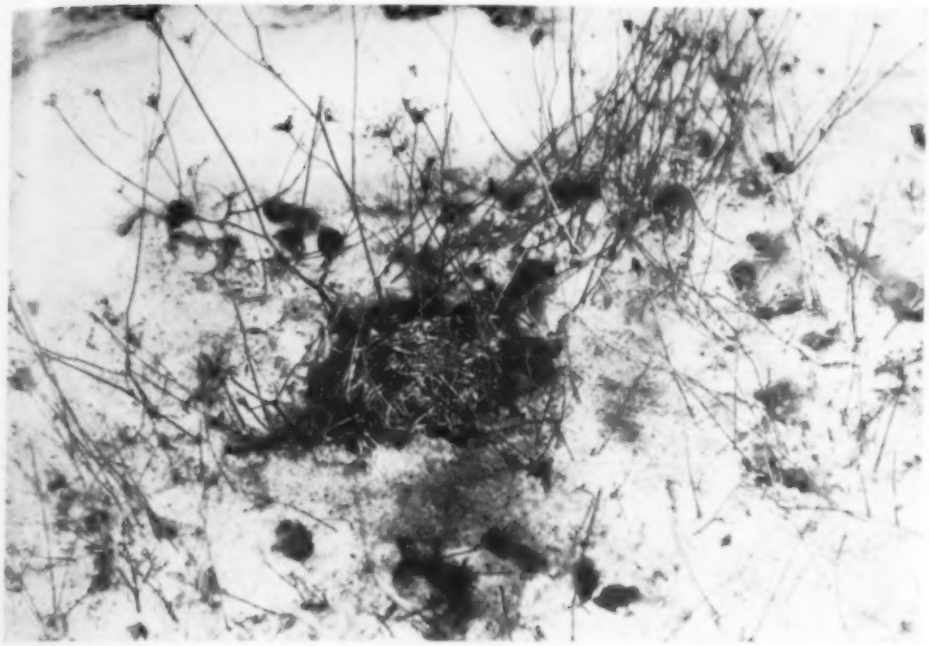
AN IDEAL HABITAT FOR FIELD MICE
UNDER DENSE VEGETATION THEY ARE RELATIVELY FREE FROM HAWKS AND OTHER AVIAN PREDATORS

by gnawing off the grasses and other succulents close to their roots; this results in a smooth highway from which the mice seldom depart. At regular intervals occur midden heaps composed of the little green dung pellets deposited by the mice. Several mice in a community may repair to these heaps, until the growth of the mound necessitates the establishment of another.

In the early spring, before the new vegetation has obscured the partly exposed highways, it is possible for one who remains perfectly still to watch the mice carry on in a perfectly normal manner. I once sat in the low crotch of a small apple tree and looked down upon a mouse drama at my feet. Some were friendly, touching noses as they met, while other cantankerous individuals would pursue all which approached too near, biting viciously at the heels of the pursued. Field mice generally appear to enjoy the company of one another. Once a field mouse becomes established in a territory, it seldom ventures far away. Several years ago I selected an extensive field which had a large population of mice. By using small metal box traps designed to capture the mice alive, I was successful in taking several hundred. These were all marked so that each individual could later be recognized. Once marked, the mouse was liberated, and after each recapture a record of the place of capture was made. The mouse was again released. In this manner it was established that field mice seldom encompass an area exceeding that of a tennis court; individuals may often spend their entire lives on a plot not greater than a tenth of an acre.[1]

Many animals possess a regular activity rhythm. Thus the deer-mouse is active only by night; tree squirrels seek

[1] Hamilton, *Ecology*, 18: 259–262.



A WINTER MOUSE NEST

THE BODY HEAT OF THE INHABITANT MELTS THE SNOW AND EXPOSES THE SNUG WINTER QUARTERS. NOTE THE EXTENSIVE SUBNIVEAN TUNNELS.

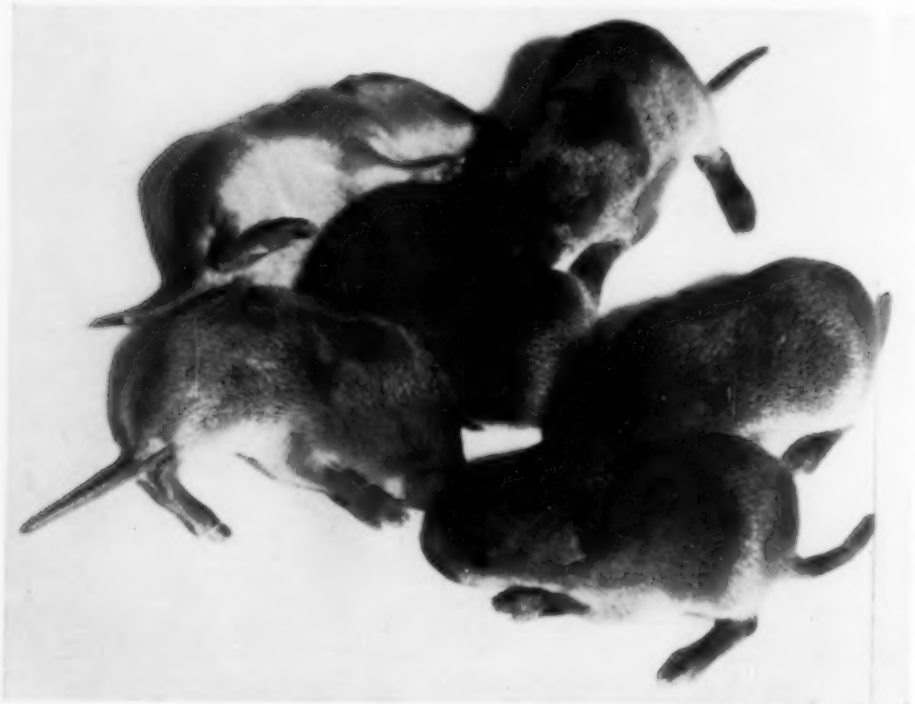
their food chiefly by day and rest at night. Field mice can have little other than cat naps, for they are up and about at all hours. By placing a few oat flakes (of which they are inordinately fond) in the runways at many points and recording the time at which the bait was removed, it has been possible to determine when the mice were most active. A thousand records made hourly throughout the day and night under natural conditions suggest that these little rodents are most active shortly after dawn and again just before dusk, although there is scarcely any period of the night or day when the mice are inactive.[2] These observations are of great importance to one who wishes to control the mice.

Feeding Habits

Field mice are preeminently vegetarians. To list all the plants eaten by the various species of Microtus would fill the pages of this journal. In the timothy field they cut through the base of the long crowded stalks. These stand so close that they can not fall, but the mice, undeterred, continue to cut match-length sections away until the plump heads are within reach. Thus is explained the little piles of stem sections one often finds in the hay field. In the alfalfa field the mice find a rich haven of food and shelter. The tough basal stalk is cut through by the little yellow razor-sharp incisors of the mice, bringing to earth the succulent terminal leaves, which are speedily stripped from the stem. But these mice, like many other small herbivores, are profligate feeders, and scarcely have they destroyed the greater part of a plant for a hasty meal than their attraction is drawn to another.

During the summer food is abundant,

[2] *Ibid.*, pp. 255–259.



WEEK-OLD FIELD MICE
THEIR EYES WILL OPEN IN ANOTHER DAY, AND A FEW DAYS LATER THEY ARE WEANED.

and the mice feed lavishly. But there comes a time when the killing frosts of autumn put an end to such variety, and the mice must seek other food. Under cover of snow, the mice carry on their subnivean activity, for there is no winter sleep for these active fellows. Food, while not so varied, is yet abundant, and the mice remain fat and sleek. Where orchard grass is abundant, the mice push into the clump, feasting on the blanched shoots or blades, which remain green far into the winter. The wild cherry trees in the hedgerow attract the mice, and with the approach of spring the white girdled bases contrast sharply with the brown bark above. We are little concerned so long as the mice girdle only the small trees of waste land, but when they invade the orchards and attack young fruit trees, often destroying great numbers, action must be taken.

Their food is not restricted solely to the plant world, for small insects, snails and other minute life provide variety. On the salt marshes there is an abundance of small fry on which these mice feed, and inland the meadows teem with insects which are not scorned by the little rodents. Indeed, they are not adverse to eating their own kind, and occasionally turn cannibal.

Their appetite is prodigious, and one seldom collects a specimen the stomach of which is not distended with finely chewed vegetation.

Captive mice have been known to consume their own weight of green food every 24 hours. It is quite possible that their food consumption under natural conditions is equal to this, for the mice have more opportunity to exercise and carry on their normal activities. Adult mice weigh from 40 to 50 grams, but the

average weight, including young and immature animals, probably averages about 30 grams. In an alfalfa field, a population of 100 mice per acre (not a particularly heavy concentration) would, during the growing season, be capable of eating nearly 300 pounds of potential hay. This is not in itself a major loss, but, as we have seen, ten times that amount is destroyed in securing the tender tips which most delight the mice.

Breeding

The field mice of northeastern United States are the most prolific breeders of all mammals in the world. In years of mouse abundance, one litter follows another in rapid succession, until it seems the meadows and fields will boil over with the little rodents. The mice are promiscuous, females accepting the attentions of any male. Within a few hours after partus, sometimes sooner, the female is again mated. The young, like other mice, are blind, naked and helpless at birth, weighing not more than a penny, but grow rather rapidly. If the nursing parent is alarmed, she will flee the nest, the young clinging desperately to her teats. If one should be lost in this precipitous flight, the mother makes a cautious return, quickly grasps the youngster and makes off to her new quarters. Within a week after birth the teeth have appeared, and the body is covered with a short velvety covering. When eight or nine days old, the eyes open and the youngsters commence to crowd the nest, seeking cover if disturbed. They now take an interest in tender leaves and other green delicacies. The young mice are weaned before they are two weeks old, but usually remain with the mother for a few days longer. Soon it is time for the arrival of another litter; the growing young make off to establish their own quarters and are soon busy with family duties.

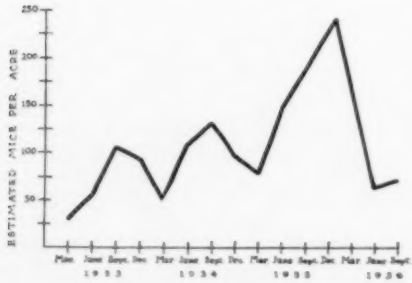
Their breeding potential is graphically described by Bailey:[3]

> In captivity the young, if well fed, begin to breed when less than half grown, the females mating with older males when only 25 days old

[3] Bailey, *Jour. Agr. Research*, 27: 528, 1924.

FIELD MICE ARE THE WORLD'S MOST PROLIFIC MAMMALS

THESE 14-DAY-OLD YOUNGSTERS ARE ABLE TO SHIFT FOR THEMSELVES, AND WELL THEY MUST, FOR THE MOTHER WILL PRODUCE ANOTHER LITTER A WEEK HENCE.



THE RISE AND FALL OF POPULATION
FIELD MICE INCREASE IN NUMBERS DURING THE SPRING, SUMMER AND FALL MONTHS BUT DECLINE DURING THE WINTER. POPULATIONS MAY RISE FOR THREE OR FOUR YEARS. FINALLY EPIDEMIC STALKS THE FIELDS AND MEADOWS, AND THE MOUSE MILLIONS ARE DRASTICALLY REDUCED. THE GRAPH INDICATES POPULATION TRENDS ON 20-ACRE FIELD OVER A PERIOD OF SEVERAL YEARS.

and having young when 45 days old, and the young males mating when only 45 days old. . . . The breeding activities are practically continuous, the females mating immediately after the birth of the young and producing litters of usually 4 at first, but when full grown, after the first or second litter, usually six or eight at a birth. Seventeen consecutive litters of young have been produced by one female in captivity within a year—May 25, June 14, July 8, July 29, August 23, September 18, October 18, November 9, November 30, December 21, January 12, February 2, February 23, March 18, April 8, April 30, May 20—and then she showed no signs of being near the end of the breeding period, while several generations of her young have busily followed her example, one of them, born on May 25, having produced 13 families of young totaling 78 in number, before she was a year old.

Small wonder the fields are so thickly populated!

The attainment of sexual maturity at an uncommonly early age, the very prolific nature of these mice, the attendant cares and physical strain and finally, the ceaseless activity of these small animals in their search for food both day and night all take their toll. Trapping records during late winter show an almost total absence of adult mice. Inasmuch as long observation does not suggest different habits between the young and old, it has been assumed that there is a high mortality among the mature mice at this season. Thus the mice are short-lived, their natural life span in the wild apparently not extending beyond a year, or two at the most.[4]

Mouse Populations

Like the snowshoe rabbit of Canada and the lemmings of Norway, empire among the field mice has its rise and fall. Incredibly abundant one summer, scarcely a mouse will be seen the following year. What occasions these mouse plagues and the drastic leveling which always follows them? Obviously the prodigious reproductive rate can not continue for more than a few years, else the entire earth would be populated with Microtus.

Studies[5] in central New York indicate that the mouse cycle usually runs its course in four years. The winter of 1931–32 had been a notable mouse year, great damage in the agricultural areas of northeastern United States coinciding with the mouse hordes. Little complaint from mouse damage was heard the following winter, and diligent field observations indicated a paucity of mice. To be sure, the meadows and fields had small populations of mice during the summer of 1933, but only slowly was a population building up that would again reach its climax a few years hence. Trapping records at this time revealed a mouse population which varied between 15 and 40 per acre, depending on the habitat.

The following spring mice commenced to breed earlier, and it was noted that the litters were larger than in the two preceding years. Moreover, the increasing numbers allowed more opportunity for receptive females to meet fecund males, and the breeding rate was considerably accelerated. During the fall

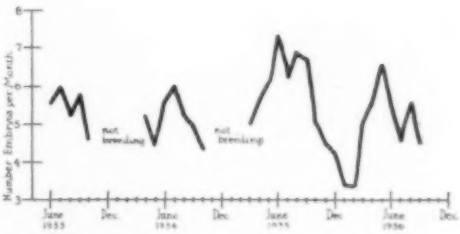
[4] Hamilton, *Amer. Naturalist*, 71: 500–507, 1937.

[5] Hamilton, *Jour. Agr. Research*, 54: 779–790, 1937.

of 1934 mouse populations had increased until the mice numbered 35 to 140 per acre in various habitats. In spite of the cessation of breeding during the winter months, and the normal mortality which always accompanies this season, the mouse population continued to gain. By the fall of 1935 mice were everywhere. Many had been crowded out by their relatives and had left the choicer localities, settling in less favored regions, even venturing some little distance into wood lots, which they seldom choose as a home site.

Previously the mice had continued breeding into late October or early November, but few young and no gravid females had been encountered later in the year than this. During the winter of 1935–36 many of the mice continued to breed, and although the litters were smaller than those of the preceding summer, the additional births largely offset the natural mortality which accompanies the winter months. Mice continued to be extraordinarily abundant, and reasonably accurate census methods revealed there were between 200 and 300 mice per acre in favorite localities (equivalent to about 3 or 4 mice to the living room of a small residence).

Until the early spring of 1936, all mice that were examined appeared to be in good health. During March a decrease in numbers was noted, and an occasional mouse was taken which indicated a diseased condition. Efforts were made to take large numbers of mice alive and uninjured. These were placed in spacious pens. Many of the mice soon became sluggish, the fur stood on end, becoming damp and slightly oily, and lethargy was pronounced. After incipient drowsiness, a characteristic spasmodic twitching of the neck and shoulders was manifest, the animal soon falling on its side. Watery discharges from the vent and gasping accompanied this final stage, the animals thrusting



THE BIOLOGY OF A MOUSE CYCLE

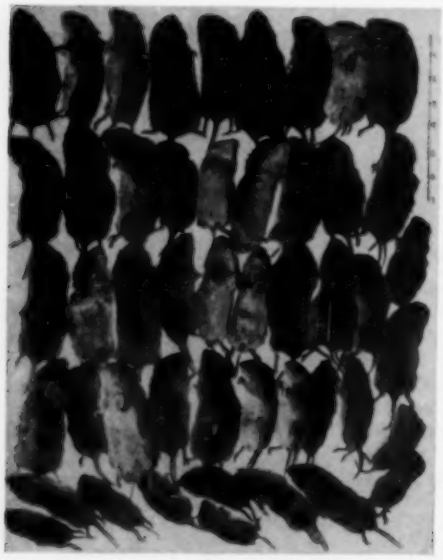
DURING THE LOW OF A CYCLE, BREEDING IS CURTAILED—THE MICE HAVE FEWER LITTERS AND THESE ARE USUALLY OF SMALL SIZE. BREEDING IS REDUCED OR CURTAILED ENTIRELY DURING THE WINTER. AS THE MOUSE NUMBERS INCREASE, BREEDING IS ACCELERATED, THE LITTERS BECOME LARGER AND THE SEASON OF REPRODUCTION IS LONGER. AT THE HEIGHT OF THE CYCLE BREEDING CONTINUES THROUGHOUT THE ENTIRE YEAR. THE PERIOD OF INEVITABLE DECLINE ARRIVES, AND ANOTHER CYCLE IS STARTED.

their hind legs straight backward. Convulsive activity soon resulted in death.

Necropsies were made on all the mice which died. Heart blood was removed under aseptic precautions and transferred to an agar slant, but the medium remained sterile after several days incubation, nor were any blood parasites observed. Many of the mice had large cysticercus, or the bladder worm stage, of *Taenia taenicaformis* in the liver.

Field mice always have a population of ectoparasites, but the lice, mites and fleas increased tremendously with the progress of the cycle, until at its height more than a thousand mites (*Hoplopleura acanthopus*) were often removed from a single mouse. Investigators in Great Britain have attributed the decline in mouse populations to toxoplasms in the brain. Sections were prepared of fresh brains of sick mice, but no parasite was found. In spite of such negative results, the drastic decline of the mouse population was obviously due to a disease organism.

By early summer the mice were greatly reduced, and those left to breed were not nearly so prolific as during the past year. Their numbers again slowly



MICE FROM A QUARTER-ACRE PLOT

DURING YEARS OF ABUNDANCE, THE MEADOWS AND FIELDS OF EASTERN UNITED STATES SWARM WITH THESE SMALL RODENTS, POPULATIONS OF 200 TO 300 PER ACRE NOT BEING UNUSUAL.

increased, until they were once more extraordinarily abundant during the winter of 1938–39. During the spring of 1939 no diseased mice were obtained, but the mouse population was nevertheless much reduced in the summer of 1939.

It should not be understood that the growth in population is the same for every cycle. Indeed, some peaks are reached in three years and maintained for another year. Plague conditions do not exist with every cycle; it is only when extremely favorable climatic conditions exist, and scarcity of predators and parasites is apparent, that optimum densities are reached. Mouse cycles may come and go for several decades before a culmination of favorable factors allows for mass reproduction. Moreover, it now seems apparent that cycles in adjacent parts of one state, or in adjacent states, do not necessarily coincide. Every locality may have its own cycle, although the 1932–36 cycle coincided throughout all of northeastern United States.

Mass Outbreaks

When favorable conditions prevail, mice often become incredibly abundant and mass outbreaks occur. These have attracted the attention of scientists the world over, and there exist many fine descriptions in the literature. Unfortunately, with the inevitable decline, little attention is directed to these animals until another outbreak seems imminent, and as a result little has been recorded on the biology of microtine cycles.

Usually mass production of mice accompanies agricultural modification of the land by man. In dry countries, where the mice are usually scarce, irrigation and the consequent increase of food suitable for these little animals has enabled them to increase greatly. Such a change

DESTRUCTION TO ORCHARD TREES

THIS 20-YEAR-OLD APPLE TREE HAS BEEN BADLY GIRDLED BY MICE. DIRT HAS BEEN REMOVED FROM THE TREE BASE TO INDICATE THE EXTENT OF THE DAMAGE. THIS TREE CAN ONLY BE SAVED BY EXTENSIVE BRIDGE GRAFTING.

in habitat was probably largely responsible for the 1907 Nevada outbreak, which was the most disastrous this country has ever experienced.[6]

Damage by field mice (*Microtus montanus*) first attracted the attention of ranchmen in the lower part of the Humboldt Valley of Nevada early in the spring of 1906. The following summer the infestation became severe. The movement of the great body of mice onto the rich alfalfa land was a gradual, scattering progression. By October, 1907, a large part of the cultivated lands in this district had been overrun by vast numbers of mice, and the complete destruction of the alfalfa, the chief crop of the valley, was threatened. Mice reached their greatest abundance in November, when it was estimated that on the larger ranches there were from 8,000 to 12,000 mice to each acre! Perhaps the reader can picture these hordes better by visualizing 2,000 mice scurrying about a baseball diamond (the infield). Fields were riddled by their tunnels and holes were scarcely a step apart. By midwinter the mice had been reduced to a few hundred per acre.

The damage occasioned by these pests was terrific. Entire fields of alfalfa were so seriously injured as to require plowing and replanting. Individual ranchers estimated their losses at $28,000, $20,000 and $8,000. The entire loss in the valley probably exceeded $300,000.

Mouse plagues are not a result of extensive emigration, as are the lemming hordes of Norway. The large numbers usually develop within the affected districts. Ordinarily several seasons are required to produce a general plague of mice, and damage is frequently noted for a year prior to a serious outbreak. When such mass outbreaks do occur, predatory animals and birds are often attracted to the scene, but their numbers can scarcely cope with the great hordes of mice. Their most effective role is in keeping these small rodents in check during years of normal abundance.

[6] Piper, *Farmers' Bulletin*, 352: 5–10, 1909.

Economic Significance

It is not the great plagues just alluded to which make these mice of such economic importance, but rather the perpetual pilfering of man's crops from year to year. This steady yearly drain, while not particularly obvious, accounts for the loss of millions of dollars to the farmer annually. When grain or corn is harvested and left long in the stack or shock, field mice eventually find it, and establish a residence in this cover, feeding almost entirely upon the kernels. Vegetables, particularly tuberous species, are avidly eaten. Nor is the flower bed immune, many herbaceous plants being cut down and partly devoured.

The farmer may ignore the presence of field mice year after year, although he suffers noticeable crop damage from these rodents. A time approaches, however, when the mice, favored by ideal climatic conditions, cause untold loss within a few days. This is particularly true in orchards, where, under cover of deep snow, the mice girdle the bases of valuable apple trees, causing eventual death of the tree if bridge grafting is neglected. Moreover, the damage may be below the ground level, and ordinarily subterranean injury is not suspected until the tree has become so weakened that the damage can not be repaired. Hedges, ornamental shrubs and small pines are peculiarly susceptible to the ravaging teeth of Microtus, but damage is seldom realized until the snow disappears, when useless measures are set afoot.

In spite of what has been said above, we can scarcely condemn these mice as useless pests. They serve as food for countless predatory animals. Among the birds, hawks, owls, crows, shrikes, gulls, herons, magpies, jays and many others feed upon them. Weasels, skunks, foxes, badgers, bobcats and even the great bears hunt industriously for these mice. Black snakes, milk snakes and other serpents

take a large toll. In the water, to which they frequently resort, pickerel, bass and other predacious fish are ever alert to snap them up. Probably no other mammal has such a long list of vertebrate enemies.

Seton[7] has aptly stated the importance of these ubiquitous creatures. He says:

> The mouse millions (*Microtus drummondi*) are doubtless the boats especially designed to bring food from the mainland of grass to the island of carnivores. . . . Indeed the flesh eaters . . . are far more dependent on the Muridae than they are even on the great ruminants. These may furnish an occasional meal, but the mice are the ever-present and reliable hunger-stay, and without them our carnivorous birds and beasts would speedily cease to exist.

In addition to these, water, in the form of high tides, inland floods or spring freshets, periodically inundates the meadows, drowning scores of the helpless young in their subterranean chambers. Pandemics are forever limiting the mouse population.

Mouse Research

Field mice have such a wide distribution, are almost everywhere so abundant and so readily captured that they are of great interest to the biologist. The mice thrive exceptionally well in captivity if provided with a sufficiency of green food, as carrots, potatoes, apples and grasses. Oatflakes, melon rind and peanut butter are avidly eaten. The field naturalist can provide himself, for a few dollars, with a hundred or more mouse traps

and proceed to capture no end of specimens. Indeed, the unbaited traps need only be placed across the runways to insure a successful catch, for the mice are totally without suspicion. A fine colony may be quickly taken in small metal box traps, or caught in one's hands by pursuing the mice before the vegetation has become too dense. Be sure to wear gloves, for the mice can inflict painful bites with their strong little incisors.

To the student of cyclic populations, field mice offer a splendid subject for research. Their availability to the investigator makes them of additional interest. Almost any college campus can boast of a small neglected spot where at least a small colony can be found.

Inasmuch as the epidemics which accompany the decline in mouse populations can now be forecast, an opportunity for research in experimental epidemiology has been opened, both under field conditions and in the laboratory.

[7] Seton, "Life-histories of Northern Animals," pp. 522–523, 1909.

HISTORICAL MAPS AND CHARTS

By JOHN M. McNEILL

CURATOR OF THE MAP AND CHART COLLECTION OF THE U. S. COAST AND GEODETIC SURVEY

ONE of the most valuable scientific collections of maps, charts and surveys to be found in the United States is that of the U. S. Coast and Geodetic Survey at Washington. The collection consists, essentially, of large-scale hydrographic maps, charts and surveys; of large-scale topographic maps and surveys; of maps of special scientific interest, such as magnetic and seismological maps and charts, maps showing geodetic surveys, etc.; and of general and miscellaneous maps and atlases. There are, in addition, a number of old, historical charts and maps, many of them of great rarity and value.

The collection at present consists of approximately 129,900 items, of which there are 53,582 nautical charts, 120 aeronautical charts (not counting separate editions), 64,158 maps and blueprint maps, and more than 12,000 hydrographic and topographic sheets showing original surveys by the Coast and Geodetic Survey. There are approximately seventy-five atlases in the collection.

The most useful topographic maps in the collection are the U. S. Geological Survey quadrangle sheets. The library keeps on file a complete set of these. Equally useful, though less extensive in areas covered, are the topographic quadrangles published by the Mississippi River Commisison and those by the U. S. Army Engineers.

Another valuable group of topographic maps is the International Map of the World series, on a scale of 1: 1,000,000. This series is far from complete as yet, but the Coast and Geodetic Survey acquires the various sheets as they are published.

The library obtains from the government of Canada the topographic maps of the National Topographic Series, which are similar to the topographic surveys of our own country by the U. S. Geological Survey.

The library also maintains files of general and miscellaneous maps and atlases for general reference purposes. This part of the collection embraces world maps and maps of foreign countries; but the greater part of it consists of maps of the United States and the various states and possessions. Many county and city maps are also included.

HYDROGRAPHIC CHARTS AND MAPS

The collection of nautical charts in the Library and Archives consists of a complete set of the bureau's own published charts; a set of the British Admiralty nautical charts; a partial set of the charts published by the Hydrographic Office, U. S. Navy Department; a set of Canadian charts, by the Canadian Hydrographic Service; a set of the U. S. Lake Survey charts, covering the Great Lakes, part of the St. Lawrence River and the lakes and canals of the State of New York; a set of the bathymetric charts of the International Hydrographic Bureau, at Monte-Carlo; and other charts of foreign origin, chiefly French, German, Russian, Danish. In addition, the library has a number of rare and valuable old charts, which will be discussed in detail later.

The charts of the Coast and Geodetic Survey form a complete chronological series, from the first charts published, in 1835, to the most recent issues. A copy of each chart, and each edition of every chart, is kept in the permanent files of the archives. The first chart of the

Atlantic coast was published in 1835; the first for the Pacific coast, in 1851; and new surveys and new chart issues have continued up to the present. The Coast and Geodetic Survey charts, therefore, constitute a historical record, of the greatest value, of the hydrographic and topographic conditions and changes along our coasts.

An extremely useful and valuable part of the map collection is the collection of original hydrographic and topographic sheets representing surveys by the Coast and Geodetic Survey. These maps depict, on a large scale and in detail, the hydrographic and topographic features of the coasts and coastal waters of the United States and Possessions. They are indispensible in the compilation and revision of the Coast and Geodetic Survey charts, and, in addition, constitute an invaluable historical record of coast-line and bottom changes along our coasts.

The library has at the present time approximately 23,000 blue-print maps. These are, for the most part, maps of surveys performed by the U. S. Army Engineers. They are large-scale hydrographic maps, covering the harbors and navigable rivers and waterways of the United States. They show water depths, shore and harbor lines, navigation channels, dangers and aids to navigation and related hydrographic information.

River Surveys

The interest of the Coast and Geodetic Survey in hydrographic surveying and mapping extends to the navigable rivers of the United States as well as to the coasts and coastal waters. There are in the bureau's map collection numerous maps and surveys of the nation's principal rivers. For the Mississippi River, the library has a complete set of the maps and charts published by the Mississippi River Commission. For the Missouri River, there is a set of charts by the U. S. Army Engineers, published from 1878 to 1881. Other river surveys by the Army Engineers include the Ohio, the Tennessee, the Wabash, and Illinois and Des Plaines Rivers. The library also has the river maps published by the U. S. Geological Survey. In addition, there are numerous river surveys included in the blue-print collection and the "Hydro" and "Topo" surveys, previously mentioned.

Magnetic, Seismological and Geodetic Maps

An item of special scientific interest in the bureau's archives is an atlas or collection of maps and charts relating to terrestrial magnetism. This collection embraces all available maps on the subject, published either in the United States or by foreign countries. It includes the magnetic charts and maps published by the Coast and Geodetic Survey.

These maps by the Coast and Geodetic Survey are published at regular intervals and cover Alaska, the United States and some of the individual states. A magnetic declination map of the United States is issued about every five years. About once in ten years a series of maps is published which shows the distribution of declination, dip, horizontal intensity, vertical intensity and total intensity. Magnetic maps of individual states are published from time to time, generally appearing in special reports or publications.

The bureau also maintains a collection of maps and other materials dealing with seismology. These maps show earthquake centers, earthquake zones, distribution of earthquakes for various years, location of seismograph stations and other seismological information.

Of particular interest to engineers and surveyors are the maps published by the Coast and Geodetic Survey showing the location, extent and progress of geodetic surveys. These maps show, for the United States and the various states, the extent and progress of triangulation,

leveling, traverse and gravity investigations. The maps are revised at appropriate intervals to keep abreast of the field work.

Historical Charts

World charts: Bougainville's atlas. Among the historical maps and atlases of the library's collection, a volume of special interest is De Bougainville's atlas, entitled "Journal de la navigation autour du globe de la Frégate la Thetis et de la Corvette l'Espérance pendant les années 1824, 1825, et 1826 . . . par M. le Baron de Bougainville, Captaine de Vaisseau." This volume consists principally of pictures—natural scenery, natural history drawings, coastal views, pictures of ships—but there is a group of maps and charts at the end of the book. The charts depict the course of the expedition; the courses of surveying boats where more detailed surveys were made, and show soundings, anchorages, shoal areas and noteworthy topographic features of the coasts. The detailed maps cover areas in the Indian Ocean and Australasia; and there is a world map showing the course followed by the expedition around the world. The scenes, coastal views and other pictures in this volume are highly artistic and beautiful.

The library has in its files a group of charts published by the firm of James Imray and Son, of London. Those in the library bear dates ranging from 1849 to 1900. They are concerned primarily with the coasts of North America, but include also certain oceanic charts of the Atlantic, Pacific and Indian Oceans, as well as charts of eastern Asia and South America.

North America, Atlantic Coast: The English Pilot. The earliest sketches and surveys of the Atlantic coast of North America are to be found in the *English Pilot*, which was originally published in the latter part of the seventeenth century. The earliest volume of the *English Pilot* in the library of the Coast and Geodetic Survey bears the imprint date of 1761. This volume describes "The West-India Navigation, from Hudson's-Bay to the River Amazones," and includes forty-two maps, charts and sketches and numerous coastal views. The maps and charts cover pretty thoroughly, on varying scales, the Atlantic and Gulf coasts of the United States; and although they are inaccurate in detail and exhibit rather meager hydrographic and topographic information, they are of great interest and value historically.

The Atlantic Neptune. The Atlantic Neptune is a collection of charts, plans and views of portions of the Atlantic coast of North America, compiled and published by J. F. W. Des Barres, a British engineer and army officer, during the years 1774 to 1784. These charts cover, with more or less thoroughness, the Atlantic coast from the St. Lawrence River to the Mississippi delta. The surveys for these charts were performed, in part, by Des Barres himself, by Samuel Holland, another British army officer; and by various other officers, surveyors and engineers. Editions of the Atlantic Neptune were issued in 1777, 1780, 1781 and 1784. In addition, special copies were issued from time to time, consisting of selections from the complete set of charts and views, for the use of masters of vessels who required only the sheets relating to the coasts which they intended to visit.[1]

The Coast and Geodetic Survey's copy of the Atlantic Neptune consists of ninety-five sheets, many of them folded, of charts, plans and views; a page of "General Remarks" (describing the coasts of Nova Scotia and giving sailing directions); a page of "Remarks on the Isle of Sable"; two pages of "Tables," giving location of principal harbors and

[1] J. C. Webster, "The Life of Joseph Frederick Wallet Des Barres," pp. 11–19.

geographic features of the coasts of Nova Scotia. The set has recently been rebound, in three volumes, each volume having its original (or photostat of original) contents page, and a sheet of "References" or mapping symbols.

The Atlantic Neptune charts exhibit both hydrographic and topographic information. They show soundings, coast lines, shoal areas. The topography shows streams, roads, houses and other buildings. Compass directions and magnetic variation are given. Relief is shown by hachures. Many of the charts are tinted, showing land areas in light brown. Many of the views also are tinted, some in sepia, others in full coloring.

The Atlantic Neptune is regarded as one of the most valuable collections of charts ever assembled or published. The charts, generally, are based upon accurate and thorough surveys; and the workmanship displayed in the engraving and printing is of a high order. One critic has evaluated the Atlantic Neptune as the "most splendid collection of charts, plans and views ever published."[2]

Blunt's Charts. After the Revolutionary War, British charts of the American coasts fell into disuse, and were gradually replaced by charts of American origin. The Navy and the Bureau of Topographical Engineers, of the War Department, engaged in surveys, and produced maps and charts, some of which are to be found in the Coast and Geodetic Survey library. Edmund Blunt, later an assistant in the Coast and Geodetic Survey, was engaged, from 1795 to 1836, in the publication of the *American Coast Pilot.* He also published numerous charts, covering the Atlantic coast of North America, the coasts of Central America, the West Indies and the northern coasts of South America. These charts bear various dates, ranging from 1813 to 1863.

[2] Rich, in his "Bibliotheca Americana Nova," I: 249; quoted in Webster, *op. cit.*, p. 15.

Pacific Coast: Spanish Explorations. The earliest hydrographic surveys of the Pacific coast of what is now the United States were made by various Spanish explorers. The "Atlas para el Viage de las Goletas *Sutil* y *Mexicana* al reconocimiento del Estrecho de Juan de Fuca en 1782," published in 1802, embodies the discoveries and surveys of many early Spanish explorers. The original of this atlas is in the Library of Congress; but the Coast and Geodetic Survey has a photostat copy of it, received as a gift from Mr. James W. McGuire. The atlas contains nine charts and maps, covering the entire coast from Lower California to Unalaska Island.

Vancouver's Explorations. Captain George Vancouver, of the British Navy, made three exploring expeditions to the Pacific coast of North America in the years 1792, 1793 and 1794. His explorations covered the coast from Lower California to Cook Inlet and Kodiak Island, Alaska. The Coast and Geodetic Survey has a copy of the atlas which was published from these explorations of Vancouver. The set consists of nine detailed charts or maps of the coast; a chart of the Sandwich or Hawaiian Islands; a chart of part of New Holland; a general map showing coastal outlines and depicting the courses of the expeditions; and six sheets of coastal views.

The maps of Vancouver became widely known and used. They were extensively copied by the famous English cartographer, Aaron Arrowsmith; and later by the British Admiralty, as bases for Admiralty nautical charts. They remained in use with but little change until 1850.[3]

U. S. Exploring Expedition. The U. S. Exploring Expedition was sent by the United States government in 1838 to explore and survey the northwest coast, to visit and examine the Hawaiian

[3] H. R. Wagner, "The Cartography of the Northwest Coast of America to the Year 1800," Vol. I, pp. 253–54.

and other groups of islands and to make calls at certain specified world ports. The expedition circumnavigated the earth and returned to New York in 1842.

The expedition was engaged in exploring and surveying the northwest coast, including the Strait of Juan de Fuca, Puget Sound, the Columbia River and San Francisco Bay, from May to November, 1841. The results of these surveys were embodied in maps and charts, the engraved plates for which are in the possession of the U. S. Coast and Geodetic Survey.

Early Charts of Alaska. The earliest explorations of Alaska were made by Russians. Bering explored, in 1727, the strait that now bears his name. Again, Bering and Chirikof, in 1741, explored the southern coasts of Alaska and the Aleutian Islands. There ensued numerous other explorations, by Russian, Spanish, British and French expeditions. Captain James Cook explored the Alaska coasts for England in 1778; La Perouse, for France, in 1785; and, again, Vancouver, for England, in 1793–94. Spanish expeditions were sent out, at various times, under command of Perez, Cuadra, Arteaga, Martinez, Fidalgo and others.

The first reliable charts of Alaska were made by Russian authority. In 1785, the Russian government sent out a scientific expedition, under command of Captain Joseph Billings, to explore eastern Siberia and Russian America. Accompanying this expedition was Lieutenant Sarychef (or Sarichef) of the royal Russian navy. During the course of the expedition, he made surveys of the Alaska coasts, particularly of the Aleutian Islands; and subsequently published the "most complete and reliable charts" of those islands that had ever been published.[4] A set of these charts by Sarychef is in the Coast and Geodetic Survey library.

Vancouver, as a result of his explorations of 1793–94, mapped the coasts of Alaska as far north as Cook Inlet and Kodiak Island. These maps are in the Vancouver atlas, mentioned previously.

The charts of Tebenkof, a governor of Russian America from 1845 to 1850, are considered the best and most complete charts of Alaska produced before the purchase of Alaska by the United States. These charts were published by Tebenkof in 1852. They embody the results of all the explorations "of the previous twelve years, together with many of former periods."[5] These charts cover not only the coasts of Alaska, but also the Pacific coast down to the southern extremity of Lower California.

With the cession of Alaska to the United States in 1867, the functions of surveying and charting the coasts and waters of the Territory were transferred to the U. S. Coast and Geodetic Survey. Surveys were begun by this bureau in 1867 and have been continued up to the present. All the surveys, as well as the published charts, produced by the Coast and Geodetic Survey, are to be found in the archives of the bureau.

Philippine Islands. For the Philippine Islands, the Coast and Geodetic Survey has a group of Spanish charts, published by the Direccion de Hidrografia, at Madrid. There are 112 charts in this group, covering, on various scales, the entire archipelago. They range in date, approximately, from 1830 to 1900.

Miscellaneous Historical Charts

In addition to the special groups and sets of charts described above, the Coast and Geodetic Survey has a number of miscellaneous old charts, of historical interest. Among these is a chart of the coast of Maine, in ten sheets, published by Sewanee Porter, in 1837 (tracing); three charts by Samuel Lambert covering the coasts of New England from Penmaquid Point, Maine, to New London, Connecticut, published 1812, 1813, 1822

[4] H. H. Bancroft, "Works," Vol. 33, p. 297.

[5] Bancroft, *op. cit.*, p. 576.

(revised ed. 1847); a chart of Georges Shoals by the Board of Navy Commissioners, 1821; and a chart of Georges Shoal and Bank, surveyed by Lieutenant Charles Wilkes and published by the Navy Commissioners, 1837.

For Boston and Boston harbor, the library has a French chart, dated 1693 (facsimile copy of tracing, obtained from Boston Public Library); a plan of Boston and of Boston harbor, in 1774, published by A. O. Crane; a chart of "Boston, its Environs and Harbour," dated 1775, made from the observations of Lieutenant Page and the plans of Captain Montresor; and a chart of Boston Harbor surveyed in 1817 by Alexr. S. Wadsworth, of the U. S. Navy.

Cape Cod and Cape Cod Harbor are shown on a chart prepared under the direction of Major J. D. Graham, of the U. S. Topographical Engineers, in 1833, 1834 and 1835. This map is remarkable for its beauty of engraving and its wealth of hydrographic and topographic detail.

A chart by Captain Paul Pinkham, in 1791, shows Nantucket Island and Martha's Vineyard and adjacent coasts and waters.

For Narragansett Bay, there is a chart of 1777 by Charles Blaskowitz; and a chart from surveys in 1832, by Captain Alexr. S. Wadsworth of the U. S. Navy.

A Revolutionary War map, dated 1778, of Sandy Hook and environs shows the position of the British fleet under command of Lord Howe.

Delaware Bay and River are shown on a chart of 1823, published by H. S. Tanner, of Philadelphia. A chart of Chesapeake and Delaware Bays, compiled and published by Fielding Lucas, Jr., in 1840, shows not only the two bays mentioned but also the coast and coastal waters from Cape Henlopen to Cape Charles and the rivers tributary to Chesapeake Bay. Water depths are shown in the principal rivers, as well as in the Chesapeake and Delaware Bays.

The south Atlantic coast of the United States, from Cape Lookout to Cape Canaveral, is shown on a chart of 1810, by the noted English cartographer, Aaron Arrowsmith. The coasts of North Carolina are represented on two old charts, one by James Wimble, in 1738; the other by Thomas Coles and Jonathan Price, in 1806. A special chart of the North Carolina coast is one of Croatan and Roanoke Sounds, showing the location of proposed embankments and a proposed new inlet, by Hamilton Fulton, in 1820.

Charleston Harbor, South Carolina, is shown on another of Arrowsmith's charts, dated 1810. "Charleston Harbour and the adjacent coast and country" are depicted on a large-scale (1:15,840) chart by the Topographical Engineers, from surveys of 1823–1825. This chart is very detailed and complete, for both hydrographic and topographic information.

For the Gulf coast of the United States, there is in the library files a "Chart of the Sea Coast of the State of Mississippi, surveyed in 1829, by John Wheeler, Engineer" (published as Sen. 1st Ses. 26th Cong. Doc. 163).

The Pacific coast is represented primarily by the charts of Commander Cadwalader Ringgold, of the U. S. Navy. He had been a member of the U. S. Exploring Expedition, but continued his surveying and charting activities after that expedition was terminated. Of these charts and maps by Ringgold, the following are contained in the Coast and Geodetic Survey's collection: "Farallones Entrance to the Bay of San Francisco, Bays of San Francisco and San Pablo, Straits of Carquines and Suisun Bay, and the Sacramento and San Joaquin Rivers"; "the Farallones and Entrance to the Bay of San Francisco"; "Sacramento River from Suisun City to the American River"; "Straits of Carquines and Vallejo Bay"; "Vallejo and Mare Island Strait"; "Anchorage off

San Francisco"; "Anchorage off Sacramento City"; "Anchorage off New York of the Pacific"; San Pablo and San Francisco Bays; Suisun and Vallejo Bays. All these charts by Ringgold are dated 1850.

There is also in the library a chart of Suisun Bay and the Straits of Carquines, dated 1850, from the manuscript map by Commodore Thomas Ap. Catesby Jones, of the U. S. Navy. Also, for San Francisco Bay, there is a chart of 1789 by A. Dalrymple, taken from a Spanish manuscript; and a chart by G. G. and J. Robinson, London, published in 1798. The two latter show very little but the outlines of the coast.

Miscellaneous Historical Maps

Coast and Geodetic Survey Civil War Maps. During the Civil War, the Coast and Geodetic Survey (then called the U. S. Coast Survey), acting in cooperation with the Union army and navy, performed many surveys and produced numerous maps and charts, of a special military nature. These maps are limited to the territory occupied by the Confederacy. They were invaluable to the Union forces in the prosecution of the war, and now constitute historical records of great value. In matter covered, they range from general topographic maps to sketches showing minute details of battle-fields, forts and fortifications; and from comparatively small-scale hydrographic maps to detailed surveys of harbors, channels and obstructions.

Old and Historical Maps in the General Map Files. In the general map files of the library are many old maps of historical worth and interest. These maps cover various states and various areas in the United States.

Maine. The State of Maine is shown on an old "Map of the District of Maine, Massachusetts," made under order of the General Court and drawn by Osgood Carleton; published by B. and J. Loring, 1802. The northern boundary of the area is incorrect (not yet having been determined), and the interior is mostly blank. Greater detail is shown for the coast and for the more developed inland region paralleling the coast.

New Hampshire. New Hampshire is represented by a handsome piece of cartography by Philip Carrigain, dated 1816. The map is detailed and clear, showing all physiographic and artificial features of interest. In addition to the main map, there are a number of artistic hand-drawn views and the following inset maps: "The States of the Union east of the Hudson, with the adjacent British Colonies"; "The Middle, Southern, and Western Sections of the United States with the Territories."

Massachusetts. A very detailed and thorough map of the State of Massachusetts is Simeon Borden's "Topographic map of Massachusetts . . . made by order of the Legislature," dated 1844. This map shows a wealth of physiographic and cultural detail, all clearly and distinctly represented. Appearing as an inset on the same map and bearing the same date is a "Geological map of Massachusetts, made by order of the Legislature," by Edward Hitchcock.

The township of Blackstone, Worcester County, Massachusetts, is shown on a map of 1854, by H. F. Walling. There is also a map of Norton Township, Bristol County, Massachusetts, by the same author, dated 1855. These are comparatively large-scale maps (Blackstone about 60 rods to an inch, Norton 80 rods to an inch), and show all details of the topography. Magnetic variation is also shown.

The islands of Nantucket and Tuckernuck are shown on a map of 1838, surveyed by William Mitchell. Topographic and geographic details are shown, including the plan of the town of Nantucket and the location of houses in the open country. Magnetic variation is indicated by a compass rose.

Rhode Island. For the State of Rhode

Island, the library has an old map by James Stevens, published in 1831. In addition to topographic details, this map shows soundings in Narragansett Bay, lighthouses and the ship channel to Providence. Roads or turnpikes are shown, with their names; factories, shops, schools, churches, hotels, dwellings and names of inhabitants are shown. Wooded areas are indicated by small pictorial drawings of trees. Names of geographic features, including hills, swamps and small streams, are given.

A map of Rhode Island by Henry F. Walling, in 1855, is of especial interest because of its thoroughness and completeness of detail and for the plans of towns which are inserted upon it. There are plans of Providence, Newport, Pawtucket, Warren, Woonsocket, Bristol, Greenwich and Westerly Village.

Another map of the state, taken from Walling's surveys, and published by John Douglass of New York, in 1862, also carries numerous city and town plans. There are no less than sixty maps of various cities, towns and villages, appearing as insets surrounding the main map.

Long Island and New York City. For New York City and vicinity, and Long Island, the library has a number of interesting old maps. There is a map of Long Island with the environs of New York, published by J. H. Colton, in 1836. It is not on a large enough scale (2½ miles to an inch) to show much detail about the city, but roads, houses in the open country and other topographic details are clearly represented. A map entitled "Map of the Country Thirty Miles round the City of New York," by I. H. Eddy, published in 1842, depicts the country surrounding the city; and for New York Bay, shows channels, shoal areas, water depths and lights and buoys. Of similar nature is a map of the country thirty-three miles around New York City, copyrighted 1846, by J. H. Colton; and the same map with corrections to 1879, published by G. W. and C. B. Colton. The two latter maps show much more hydrographic detail for New York Bay and harbor than is shown on the Eddy map.

New York City. For New York City, the library has a number of maps of historical interest. The earliest of these are two photographic maps from originals owned by the Italian government. They are Dutch maps, one being entitled "Afbeeldinge van der Stadt Amsterdam in Nieuw Neederlandt," date depicted 1660; and the other showing Manhattan Island, Staten Island, New York Bay, Hudson River and adjacent coasts of New Jersey and Long Island. The date of the situation portrayed by the latter map is 1639.

Another map of New York City is entitled simply "New Yorke, 1695," no author being given, but bearing the statement that it was lithographed by G. Hayward "for D. T. Valentine's Manual" in 1851. New York City in 1728 is shown on a map by William Bradford, taken from surveys by James Lyne. A map dated 1797 shows details of the city (streets and names, wharves, etc.) for that date. This map, like the one mentioned above, bears no author's name, but was lithographed by G. Hayward "for D. T. Valentine's Manual," 1853. Another map, copied from the map of D. Longworth, shows the city in 1808. New York City in 1851 is shown on a beautifully engraved map of the "City and County of New York, and the adjacent Country," published by Sherman and Smith in 1851. This map shows original shore lines, proposed development beyond the original shore lines and the topography of the area. Relief is indicated by hachures, and steepness of slope by degrees of shading. Woods are represented by small pictorial drawings of trees.

Two maps that emphasize particularly the topographic and shore-line changes that have accompanied the growth of

New York City are the "Map showing the High and Low Water mark and the original City Grants of Lands under Water made to various parties from 1688 to 1873," by the Department of Docks, 1873; and the "Topographical Atlas of the City of New York, including the annexed territory, showing original water courses and made land," by Egbert L. Viele, 1874. The former shows coastline changes, primarily, together with the successive extensions of pierhead and bulkhead lines. The latter shows not only alterations in the shoreline, but also the original topography of the land, including marshes, meadow lands and water courses. Relief is indicated by hachures.

New Jersey. For the State of New Jersey, the map collection includes a map of "The Providence of New Jersey, Divided into East and West, commonly called The Jerseys." This is a reproduction by the Geological Survey of New Jersey of the original map engraved and published by William Faden, London, in 1777. On this map, the topography is painstakingly and fully shown, relief being represented by a liberal use of hachures. Roads, towns and human habitations are shown. The dividing lines between East and West Jersey are shown. Shoal areas, oyster beds and ship channels in Delaware Bay and River are depicted.

There is also a map of New Jersey by William Watson, in 1812, which, although more recent, does not exhibit the fullness of topographic detail shown on the Faden map. It shows the dividing lines between East and West Jersey, one, called Keith's Line, surveyed in 1687; the other, Lawrence's Line, surveyed in 1743.

A map of New Jersey "compiled under the patronage of the Legislature of said State" by Thomas Gordon, in 1833, is quite detailed, and has a very finished and artistic appearance. On this map, cultural features are emphasized—roads, towns, mills, forges, churches, taverns, dwelling houses, canals and railroads being shown. It is on a comparatively large scale (three miles to an inch), so that the numerous details are shown without any appearance of crowding.

Pennsylvania. The State of Pennsylvania is the subject of a map by Reading Howell, dated 1811. The map shows counties, townships and drainage; and emphasizes the works of man—churches, dwelling houses, forges, grist mills, saw mills, canals, towns, Indian towns, roads, Indian paths and bridle paths being shown. This map also gives an interesting picture of the early development of Pennsylvania, the southeastern section of the state, near Philadelphia and the Delaware River, displaying much more cultural detail than is shown on the rest of the map.

An excellent early map of Pennsylvania is that by John Melish, copyrighted 1822, corrected to 1832. This is an official map of the state, authorized by act of the legislature, compiled and drawn from official county surveys. It is very complete and detailed in every respect.

The city of Philadelphia is shown on a beautifully engraved map of 1796, by John Hills, surveyor and draftsman. The engraving was performed by John Cooke, of Hendon, England. The map is on a scale of 600 feet to an inch, and shows details of the city as it was at that time, together with proposed streets and developments. The map painstakingly depicts hills, valleys, streams, lakes and wooded areas. Street names and numbers are given; and, for the water front, wharves with their names or designations of ownership are shown.

Philadelphia and the area surrounding it within a radius of ten miles are exhibited on a map by John Hills, from surveys of 1801–1807. This map embodies a wealth of historical lore, showing names of roads, taverns, inns, churches, location of "gentlemen's

seats" or estates, with names of owners; farms and names of owners; location of schools, dwelling houses and mills.

Maryland. The State of Maryland is represented in the collection by three maps of distinct historical worth. The earliest of these is a "Map of the State of Maryland laid down from an actual Survey of all the principal Waters, public Roads, and Divisions of the Counties therein; describing the Situation of the Cities, Towns, Villages, Houses of Worship and other public Buildings, Furnaces, Forges, Mills, and other remarkable Places," by Dennis Griffith, in 1794. An inset on the main map shows the "Federal Territory" and plan of the city of Washington. The map was engraved by Thackara and Vallance, of Philadelphia.

Maryland in 1840(?) is depicted on a map by Fielding Lucas, Jr., of Baltimore. In addition to full topographic and cultural detail, this map also shows the hydrography of Chesapeake and Delaware Bays and of the Potomac River to Washington.

Maryland at the close of the Civil War is shown on a map, produced "under the patronage of the Legislature," by Simon J. Martinet. This map is extremely detailed and thorough, especially in the cultural aspects of the topography. All roads of any consequence are shown, and distances between points are indicated. Mills or factories are shown, and distinguished by note according to product. Hotels, taverns, schools, churches, colleges, blacksmith shops, wheelwrights, mines and quarries and many other details are shown. Churches are distinguished according to denomination by appropriate abbreviations. Chesapeake Bay and the larger rivers show soundings and lighthouses. The map is also of interest because of a number of city and town plans inserted upon it. There are plans of Annapolis, Baltimore, Cumberland, Frederick, Hagerstown, and Washington and Georgetown.

The library has a map of the city of Baltimore by Fielding Lucas, Jr., dated 1845, which presents an accurate and clear picture of the city at that date.

Potomac River. There are in the archives of the Coast and Geodetic Survey three maps or tracings of early surveys of the Potomac River. One shows the river from Great Falls to Chopawamsic Creek. This sheet is signed by R. O. Brooke and is dated 1737. The second, entitled "The Platt of Stafford," shows the river from Chopawamsic Creek to Upper Machotich Creek. It is signed by Jno. Savage and is undated. The third shows the Virginia shore from the mouth of Yocomoco River to the mouth of the Potomac; and continuing, shows the Virginia shore of Chesapeake Bay to Rappahanock River, then follows that river up to Morattico Creek. This tract was surveyed by William Ball and is dated 1736.

District of Columbia. Maps of the District of Columbia form an important group in the map collection. A number of old historic maps of the District have been reproduced and published by the Coast and Geodetic Survey. These include the L'Enfant plant of the city of Washington, 1791; Andrew Ellicott's map of the District, 1791–93; the Dermott, or "Tin Case" map of Washington, 1797–98; and the King Plats of the city of Washington, 1803.

In 1792, Thackara and Vallance, of Philadelphia, engraved and published a map of Washington, a copy of which is in the Coast and Geodetic Survey collection. Another interesting map is the "Plan of the City of Washington. . . . Drawn from the original plan adopted and signed by J. Adams, President of the U. S.," drawn by W. Elliot, in 1822. There is also in the collection a copy of the "Stone Plate" of Washington, engraved by W. J. Stone, about 1839. A feature of this map which is of especial interest is the clarity with which it shows the course of Tiber Creek and its tributaries within the city.

Albert Boshke, at one time an em-

ployee of the Coast and Geodetic Survey, produced some noteworthy maps of Washington and the District of Columbia. His map of Washington published in 1857, in addition to its being a valuable historical record of the city's growth at that time, is an elegant and very thoroughly detailed piece of work. It not only portrays the wards and the street and block plan of the city, but for each block shows the boundaries of lots and the configuration of building lines. Government buildings and other important buildings are shown and named, names of squares are given, and reservations and park lands shown. Soundings are shown in the Potomac and Anacostia (Eastern Branch) Rivers.

A map of the District of Columbia by Boshke, published in 1861 (from surveys of 1856–59), is similarly detailed. It shows all roads, forested and cleared lands, property boundaries and names of owners—in brief, all details of the topography. The plan of Washington on this map is similar to the one described above, though on a smaller scale.

The library has two maps by William Forsyth, a former surveyor of the District of Columbia. One is a map of Washington and the built-up suburban areas, dated 1870; the other, a map of Georgetown, dated 1871. These maps display an unusual minuteness of detail, the Washington map showing not only the customary street names and numbers, important buildings, reservations, and the like, but also showing the dimensions of blocks and sidewalk and building lines. The map of Georgetown goes into still more minute detail, showing the numbers, boundaries and dimensions of individual lots.

Later maps of the District of Columbia possessing historical value are those of the District engineer department. Of these maps, the library has a representative set, ranging in date from 1884 to the present time.

The U. S. Coast and Geodetic Survey has published two topographic maps of the District of Columbia, from its own surveys. One is a set of fifty-eight sheets, on a scale of 1:4800, issued at various times from 1881 to 1893; the other, a set of six sheets, on a scale of 1:9600, published in 1894. These maps were originally issued for sale, but are now to be found only in the bureau's archives.

Virginia. A very beautiful early map of Virginia in the library's files is that drawn by Herman Boye and copyrighted by John Tyler, governor of the state, in 1826. This is an official map, "constructed in conformity to law," from surveys authorized by the legislature. In information shown, it is very thorough and complete, showing mountains, streams, counties, roads, towns, court houses, mills, minerals, manufactories, iron works, churches, schools and colleges, bridges, fords, ferries, distances between towns; and soundings and depth contours in water areas. It also gives a wealth of geographic names, even obscure and comparatively insignificant features being carefully named.

This map, in addition to its cartographic accuracy and completeness, could be classed as a work of art. It is beautifully drawn and engraved, and delicately colored to show counties. On the margins of the map are two elegant hand-drawn and engraved views, one of the University of Virginia, the other of the city of Richmond.

North and South Carolina. An item of considerable historical value to be found in the Coast and Geodetic Survey library is a copy of William Byrd's survey of the boundary line between Virginia and North Carolina, in 1728. (This map is a tracing, not the original.)

The Atlantic coast of part of Virginia, North Carolina, South Carolina, Georgia and the upper part of Florida is shown on an old map by John Lawson, surveyor general of North Carolina, dated 1709. A very interesting old map of North and South Carolina is one entitled "An Accurate Map of North and South Carolina with their Indian Frontiers, Shew-

ing in a distinct manner all the Mountains, Rivers, Swamps, Marshes, Bays, Creeks, Harbours, Sandbanks, and Soundings on the Coasts; with the Roads and Indian Paths; as well as the Boundary or Provincial Lines, the several Townships and other divisions of the Land," etc., by Henry Mouzon and others, published by Sayer and Bennett, London, in 1775.

The city of Charleston, South Carolina, in 1844, is the subject of a map published by W. Keenan. The map is in colors; and in addition to the details of wards, blocks, street names and numbers, shows also the names or designations of all wharves and piers.

Tennessee. For the State of Tennessee, the library has two early maps, one by Fielding Lucas, Jr., undated, but bearing census statistics for 1810; the other, by Matthew Rhea, dated 1832. The first is on a small scale (about eighteen miles to an inch) and shows little detail except counties and drainage. The second is on a considerably larger scale (about seven miles to an inch), and exhibits the minuteness and completeness of detail which are characteristic of carefully made maps of that period.

Mississippi River. Besides the maps of the Mississippi River Commission mentioned earlier in this paper, the library collection includes the following old maps of the Mississippi River and Delta, which are of interest and value: "Delta of the Mississippi," surveyed in 1838 by the Bureau of Topographical Engineers, showing both hydrography and topography of the delta; and a map of the river from Natchez to New Orleans, by B. M. Norman, dated 1858. The principal feature of the latter map is its very complete portrayal of property ownership along the river—the boundaries of properties and names of owners being clearly shown. Types of plantations, whether cotton, sugar or other, are distinguished by colors.

Texas. The earliest map of Texas in the library files is the "Map of Texas and the countries adjacent," compiled by the Bureau of Topographical Engineers in 1844. It includes the territory from the Mississippi and Missouri Rivers west to the Pacific Ocean; and from south to north, reaches from Tampico, Mexico, to about the 44th parallel of latitude. Little detail is shown, however, except for the areas which now make up the States of Texas, Oklahoma and Kansas. For these areas, names of towns, streams and other geographic features are given; the routes of early explorers and travelers shown and named; and various facts regarding the native Indian tribes given. The Pacific coast area shows little except a few geographic names along the coast.

Pacific Coast. For the Pacific coast of the United States, the library has a rather numerous group of old maps. The larger part of this group concerns the State of California.

California. One of the earliest of these California maps is T. J. Farnum's map of 1845, on a scale of about fifty-two miles to an inch. It covers Upper and Lower California, part of Mexico and the area eastward to approximately the 106th meridian. It shows mountain chains and water courses, routes of travelers and explorers and location and names of Spanish missions along the coast.

A map entitled "Sketch of General Riley's Route through the Mining Districts," dated 1849, shows the coast of California in the vicinities of San Francisco and Monterey Bays, and the inland area to the eastward. It is on a scale of approximately nine miles to an inch, and shows considerable detail for coast lines, courses of streams and location and extent of marshes and highlands.

A French map entitled "Carte de la Nouvelle Californie," by Hypolite Ferry, in 1849, gives a detailed picture of the territory and its development at that time. The map was based upon the explorations and travels of Monsieur Duflot de Morfas and Colonel Fremont.

A map of the "Gold Region in California," by Charles Drayton Gibbes, 1851, constitutes a useful historical record of the state at that time. It is carefully and very clearly drawn and shows the physiographic features of the land, villages, settlements, missions, roads, with distances, fords, ferries and other information.

Other useful maps of California in the library files are the following: Maps of California showing public surveys, to accompany the report of the surveyor general, one for 1857 and one for 1860; a map of central California and part of Nevada, by the State Geological Survey of California; a "Map of the region adjacent to the Bay of San Francisco," by the State Geological Survey of California, 1873; a "Map of California and Nevada," by the State Geological Survey of California, 1874; a map of California and Nevada, by Charles Drayton Gibbes, 1876; and a map of California by the U. S. Geographical and Geological Survey of the Rocky Mountain Region, 1877, showing the distribution of Indian tribes.

San Francisco. The library has two early maps of the city of San Francisco, taken from the surveys of William M. Eddy, county and city surveyor, one dated 1850, the other, 1852. A set of maps by the Board of State Harbor Commissioners, *et al.*, dated 1877–78, show the water front of San Francisco, with proposed changes. An "Official Map of the City and County of San Francisco," by William P. Humphreys, city and county surveyor, in 1870, gives very full details of the plan and topography of the city and county. A copy of the same map revised to 1884 is also in the library. A map by the Board of Harbor Commissioners, in 1876, shows "the salt marsh tide and submerged lands disposed of by the State of California, in and adjacent to the Bays of San Francisco and San Pablo."

Oregon and Washington. The states of Oregon and Washington are represented among the historical maps of the collection chiefly by the maps of the U. S. Exploring Expedition, mentioned earlier in this paper. One of these is a general topographic map of the Oregon Territory, on a scale of approximately fifty miles to an inch. It covers the area from Cape Mendocino, California, to Dixon Entrance, Alaska; and from the coast eastward to the Rocky Mountains. Information shown on this map includes the physiography of the area, names and boundaries of Indian tribes, forts, missions, names of geographic features; and an inset map of the Columbia River, on a scale of about twelve miles to an inch.

Washington and Oregon in 1852 are shown on a map entitled "A Diagram of a Portion of Oregon Territory," by John B. Creston, surveyor general. This map covers the coast of Washington and Oregon and the area eastward to the Cascade Mountains. It is on a large enough scale (about ten miles to an inch) to show considerable information regarding the topography and development of the area.

Conclusion

The above outline and description of the U. S. Coast and Geodetic Survey's map and chart collection, although incomplete and far from exhaustive, will perhaps serve as an introduction to those who may wish to make use of it. It should be pointed out that, while the primary purpose of the collection is to serve the bureau itself, it may also be used by interested members of the public, under necessary and suitable restrictions. The cartographic resources of the bureau have been rather extensively used by the public in the past, and such use will doubtless continue and probably increase. Items in the bureau's permanent files which may be needed by the public may, unless confidential or restricted, be consulted in the Washington office or obtained in the form of photostat copies.

IN REFUTATION OF MR. A. LOVERIDGE ON "ANIMAL TREASURE"

By IVAN SANDERSON, B.A. Cantab., F.L.S., F.Z.S.
LONDON, ENGLAND

HAVING returned from a year's collecting trip in South America, I have only lately seen an article in the January, 1938, number of THE SCIENTIFIC MONTHLY entitled "If the Blind Lead the Blind Shall . . .?" by Mr. Arthur Loveridge on the subject of a book of mine entitled "Animal Treasure."

Considerable weight would be expected to attach to this article as well from Mr. Loveridge's position as assistant curator at the Harvard Museum of Comparative Zoology as from its publication in your magazine. As the author's intention appears to be primarily to discredit me personally in the eyes of the scientific world and all those organizations which do me the honor of backing my zoological expeditions, I trust that you will permit me the opportunity of replying to it.

I particularly desire to take this step, notwithstanding the length of time which has elapsed since the publication of the article because the gist of it has reappeared in the columns of various papers throughout different parts of the world at different times. Frequently Loveridge claims in his articles upon this subject that the reviews of my book "Animal Treasure" made by two well-known gentlemen, Mr. Clifford H. Pope and Mr. Hans C. Adamson, were unjustifiable.

Referring to these two reviews Loveridge states in his article that he is caused to reflect that a reviewer is in a position of trust, especially when his scientific study for technical knowledge is calculated to lend special importance to his opinions.

As the office which Mr. Loveridge holds leaves no doubt as to this scientific standing, the article which he has written must consequently be judged from the standpoint that he is in that very position of trust himself.

In opening his article about "Animal Treasure" Loveridge refers in somewhat loose and inaccurate phraseology to the origin and financial position of my expedition.

May I therefore make it clear that the expedition of which "Animal Treasure" is a popular account was made on behalf of the British Museum, Cambridge Zoological Museum and the University of London; it was made possible by substantial grants from Cambridge University; Trinity College, Cambridge; the Royal Society; the British Museum and the Percy Sladen Memorial Fund. The financial side was also, though to a lesser extent, assisted by my companion, Mr. W. M. Russell, and myself. The expedition returned to England in 1933 with approximately 7,000 specimens.

The scientific results of the expedition have been reported in the journals of several British learned societies.

"Animal Treasure" was written by me in 1935, was published by the Viking Press in America and Macmillan in London, and the fact that over 80,000 copies have been sold indicates that it is not generally regarded as a purely scientific work.

After alleging that the publishers of "Animal Treasure" had been deceived, claiming that Mr. Adamson's and Mr. Pope's reviews were unjustifiable and suggesting that my observations in the field were inaccurate, Loveridge goes on to state that "Animal Treasure" was an attempt at the exploitation of science

and was "to so large an extent a compound of misstatement, misinterpretation, exaggeration, sensationalism and emotionalism." As an opening gambit in an article this is quite good even for a scientist.

There is no truth in the suggestion that my expedition to West Africa was for my own gain or otherwise than for the furtherance of science. Also Loveridge knew from my correspondence with him before its publication that the book was purely a popular account and not a scientific work, so there can be no basis for suggesting that I had attempted to exploit science.

Loveridge himself defines the scientist, which in his article he denies me to be, as a searcher after truth, but the fact that upon that expedition alone I spent a year of serious study in the field and that the written reports of that study were accepted for publication by the leading scientific societies of England is surely evidence not only that I searched after but found the truth.

Again, it is somewhat inconsistent on the part of Mr. Loveridge to deny scientific merit to me and to pour scorn upon the expedition when, as happens to be the fact, some of the collection of 7,000 specimens which I brought back are now under his own care in the Harvard Museum of Comparative Zoology.

Loveridge then takes twenty passages from the book to support his claims and he numbers them seriatim and comments upon them. For purposes of simplicity I propose to follow his numbering and to reply to his comments paragraph by paragraph.

(1) Loveridge quotes in part from an account in "Animal Treasure" of an incident with a 'spitting" cobra and hereon he makes the observations that (*a*) I never saw the venom fall on my trousers, (*b*) but I described its color (*c*) on the basis of my assumption I imagined its effect on the eyes, and (*d*) I did not attempt to check my theories with the results of known experiments of this venom.

My reply is (*a*) I saw some of the venom fall upon a white muslin hand net and was aware that it had also fallen on my trousers. (*b*) My description of its color was as it appeared on the hand net. Mr. Loveridge refers to its color after crystallization as pale yellow or clear amber and himself therefore only by innuendo denies my statement that in liquid form it was brown. (*c*) Why not imagine its effect upon the eyes? Loveridge proceeds to state that in one out of six cases personally investigated by himself the recipient of the venom in the eyes was permanently affected and in the five other cases there was an instantaneous but transitory painful reaction. (*d*) As is evident from the quotation there was no theory to check and the only remark which was not a statement of fact is amply justified by Loveridge's own criticism.

(2) Loveridge accuses me of deliberately withholding the name of a harmless snake as disclosing it would spoil the story concerning the steps I took to mitigate the possible effects of its bite.

To begin with let me make clear that the story is a humorous one in which the laugh is turned against myself, and it does not contain any scientific matter or the name of any reptile.

One of Loveridge's general accusations against me is my lack of accuracy, but he placed sufficient reliance upon my brief description of the snake to identify it without hesitation as *Bothrophthalmus lineatus*, and he claims that it was so distinctly colored and so common that, according to Dr. G. W. Harley, even the native women recognize it as harmless.

Further, he deliberately misinterprets the story by stating: "Despite the court messenger's assurance that the man would not die—and when natives agree that any creature is harmless one may

be sure that it is — . . ." whereas the text actually reads; "I enquired of the court messenger whether the animal was deadly. He replied that it was, but that the man wouldn't die."

At the time when I wrote the story and at the time it was published our snakes, which were being handled by Mr. H. W. Parker, of the British Museum (Natural History), had only been sorted out provisionally. Mr. Loveridge knew this from a letter which I had written to him personally prior to his writing his article, in which I had told him that I did not and would not commit Mr. H. W. Parker to an identification of the snake in question, as Mr. Parker had not arrived at his decision.

(3) Loveridge denies the accuracy of the dimensions of a spider which I quoted and apparently with some glee claimed to have verified his opinion that I had exaggerated these dimensions by ascertaining from Mr. R. J. Whittick, who is in charge of the British Museum collection of arachnids, the dimensions of the largest spider which I brought back from my expedition.

It so happened that the particular spider mentioned in the book was not amongst those specimens which went to the British Museum and therefore would not have been in the collection under Mr. Whittick's charge; despite Loveridge's opinion I maintain that my measurement of the spider was correct.

(4) Loveridge refers to my description of a mantis as being absurd when I describe it as being a truly terrifying creature, apparently always willing to engage in a battle even with man. Loveridge claims they are delightful little creatures which he apparently likes keeping as pets.

This appears to be primarily a matter of opinion and taste, although in support of my opinion of them the mantidae probably display "distance threat and deflection" as defined by Huxley.[1]

[1] *Am. Nat.*, 81, September, 1938.

(5) Loveridge states as simply untrue my account that the female mantis is unable to be impregnated by the male without she eats the male.

The fact of the female devouring the male is admitted by Loveridge, but apparently the necessity is denied and in support of my observations upon the point I would quote, among leading entomologists, J. H. Fabre,[2] who studied the animals in life.

(6) Referring to my general description of the habits of *Potamogale velox* as not having advanced since its discovery by du Chaillu, so that it had become almost a zoological myth, Loveridge denies that the animal is almost mythical and asserts that I have exaggerated *its rarity* either through ignorance or with the object of magnifying the achievements of my expedition.

The paragraph from which Loveridge quotes in part shows when read as a whole that it is the absence of knowledge concerning the life and habits of *Potamogale* that prompted me to call it almost mythical and not the absence of knowledge of the existence of the animal which is specifically referred to. In the text of "Animal Treasure" (p. 228) I actually state that du Chaillu's account of the habits of the *Potamogale velox* were inaccurate, that little or nothing has been done to elucidate its habits since his time, that very little material about it has been collected for study, and no pictures of it have ever been taken in life. This is an exact statement of the position as a perusal of extant literature will prove. Its anatomy is almost entirely unknown; Dr. J. A. Allen, who, according to Loveridge, "extensively discussed" Potamogale material from the Lang Chapin expedition, actually remarks "While *Potamogale* is a rather common animal in its native haunts, it is one of the rarest in collections. . . ."[3] He nevertheless adds nothing to our

[2] "Souvenirs Entomologiques," ser. 5, p. 307.

[3] *Bull. Amer. Mus. Nat. Hist.*, 47: 4–8, 1922.

knowledge of *Potamogale* except a list of specimens with measurements.

One of the specific purposes for which we went to Africa was to collect spirit material there in order that this lack of knowledge might be rectified. We were successful.

(7) This perhaps is the most important and inaccurate of Loveridge's criticisms. He states that I have blundered and talked "utter nonsense" when he quotes from my book that:

> We captured six diurnal animals in Africa that belonged to groups all the other members of which are exclusively nocturnal. All six animals—a snake (*Gastropyxis senaragdina*), a squirrel (*Funisciurus poensis*), a monkey (*Cercopithecus pogonias*), a rat (*Oenomys hypoxanthus*), a flying squirrel (*Anomalurus beecrofti*), and, finally, a lemur (*Galago demidovii*)—were bright green above and yellow beneath, whereas their near-related and nocturnal species were all of other colours. (p. 167.)

He states that the snake, squirrel and monkey belong to diurnal groups and none of the animals conforms to my description except the snake, and "by courtesy" the squirrel.

I regret the necessity of correcting Loveridge in these observations, as all the animals referred to are bright greenish above and yellow below (see also *Trans. Zool. Soc. Lond.* (1939) Vol. xxiv, Pt. vii, No. 1, now in the press). They still show the full yellow in the preserved specimens at the British Museum. The dorsal coloration has faded (as green always does) to olive or dusty-grey-olive.

Loveridge states that the pelage of mammals undergoes no radical changes on preservation beyond a slight dulling and fading with the passage of time, but here again, I would point out that the reaction to which I have referred is, contrary to Loveridge's view, well known. Although Loveridge claims that mammalogists support this view of his, I would refer him and those mammalogists supporting him to any collector, taxidermist or museum worker for a contrary opinion.

The importance of Loveridge's criticism in this respect is that in one detail he is right. "Animal Treasure" quotes the monkeys (*Cercopithecus*) as being a nocturnal group. Loveridge is correct in stating (and I appreciate this accurate and constructive criticism) that it is a diurnal group.

In regard to the remaining species my statements are correct so far as refers to West Africa, where I have seen and figured the animals in life. Loveridge in his article does not claim to base his contradictions upon personal observation, but relies upon information which he has derived from others and a mere study of museum specimens which is apt to be misleading.

For a scientist like Loveridge to jump to a conclusion that I use scientific names without really knowing the creatures to which they refer as he does in referring to the water mongoose (*Atilax paludinosus*) shows that his investigation must be somewhat superficial and his argument weak. He denies my description of this animal as being cross-striped, and I can only say that if he would visit the Cameroons and make the acquaintance of these animals he would find that the description is peculiarly applicable to them in their young and sub-adult stages.

(8) For the full text of this criticism it would be necessary to refer to Loveridge's article, but it may perhaps be summarized as stating that Loveridge alleges that my statement in "Animal Treasure" that the skincoid lizard (*Lygosoma fernandi*) emits a noise is untrue.

The facts as stated in "Animal Treasure" were that on our returning from an expedition towards the end of the day we heard an extraordinary noise, something like a foghorn and we set off to discover what it was. After a fairly

long search and with an element of good fortune we discovered it came from a hole in the ground out of which we extracted a lizard. The lizard was injured in the course of its extraction from the hole in the ground, but before it expired, while I was holding it in my hand, it again emitted (though this time, as was natural, faintly) the sound we had heard before.

At another time I captured two of these lizards and kept them in a cage in the camp and again I heard issue from them the same noise which had originally attracted our attention.

Loveridge suggests that it is ridiculous that an animal measuring eight inches from snout to base of tail could perpetrate so great a noise as did this lizard, but I would remind him that there are Cicada only two and one-half inches in length that can be heard for two miles in Sumatra and that even in thick forests the calls of tiny lemurs (Galagos) and many birds can be heard for miles. Having denied the sources of the noise as being what we describe Loveridge himself suggests an explanation, and his explanation is remarkable, namely, that the noise we heard was made up by two sounds, presumably coinciding simultaneously, one being the shrilling of crickets and the other being the whistle of Secret Society men in the forest. I feel that Loveridge is taxing the credulity of his readers very highly indeed in introducing an explanation of such a romantic form. It appears to indicate that any theory is more probable than that which is supported by the statements of myself and my companion who were on the spot.

(9) Loveridge refers to my description of an encounter with "Baboons" (*sic*) as being my first encounter with drills in the primeval forest and consequently being about as trustworthy as the account "of the alarming honking and apparent intentions of the automobiles around it" which a baboon would give assuming it strayed into the middle of Fifth Avenue. And then Loveridge calls me an imaginative young man!

It is true that the anecdote in question was purely humorous and of no scientific value, but in reply to Loveridge's theoretical question in his criticism (not a review, let us remember) "Who has ever heard of drills attacking a man," I would mention that in this self-same primeval forest (not Fifth Avenue) a young woman had, only a fortnight before the incident related, been killed by a troop, possibly the same one, of drills (*Mandrillus leucophaeus*).

(10) In support of his claim that I am unreliable as a scientist Mr. Loveridge states that I can not even copy accurately from other authors.

In "Animal Treasure" I referred (without quoting) to Mr. G. L. Bates as having found a *male leaf toad* (*Nectophryne batesi*) sitting on a brood of eggs. Quoting from Dr. G. A. Boulanger.[4] Mr. Loveridge claimed that Mr. Bates had found a female with empty oviducts under the trough or hollow of a plantain-leaf petiole crouched in the midst of a mass of eggs.

I accept Loveridge's quotation; but Dr. Boulanger's description is taken from Mr. Bates's original field notes. We, however, had cause to examine this actual specimen, which is in the British Museum, and it proved to be a male. This discovery was made by Mr. H. W. Parker, who published it in "Proceedings of the Zoological Society of London" (1936, p. 135), a copy of which was sent to Loveridge on publication. Presumably, however, Loveridge, before embarking upon his criticism of "Animal Treasure," failed to study the extant literature.

Further, Loveridge's statement that the eggs were "beneath the base of a banana leaf apparently lying on the

[4] *Ann. Mag. Nat. Hist.* (8) 12, p. 71.

ground" is a quite unwarranted addition to Bates's note. A plantain-leaf petiole, it is elementary to point out, is customarily several feet from the ground.

Loveridge might have verified these facts while he was so busy collecting information before suggesting that I was unable to "copy from other authors without adding fantastic flourishes from" a "fertile imagination."

(11) In a lengthy series of quotations extracted from their context Loveridge seeks to prove that my method of selection of a companion on my expedition was a failure.

First, I should have thought that this was a question which the leader of the expedition was better able to decide than one who took no part in it. Secondly, it is highly improbable that a person who would prove to be a sympathetic companion to Mr. Loveridge in the field would possess those characteristics which enabled Mr. Russell and myself to achieve the successful results which my expedition brought back.

(12) Loveridge refers with disapproval to my use and enjoyment of the gramophone when working in camp in the jungle.

This again is a matter of personal taste and opinion, but it would hardly seem to be relevant as a criticism upon my standing as a scientist.

(13) With more of that sarcasm to which his readers by this stage of the article must have been becoming hardened, Loveridge quotes at length from my description of the drift of life in a tropical forest, and claims to compare it with the drift of ideas in my mind when I was a child.

The explanation regarding the drift of life (which Loveridge does not attempt to disprove) is sufficiently apparent from "Animal Treasure" (p. 75), and from considerable work in the field in other tropical forests I am able to confirm it, despite Loveridge's scepticism.

(14) Loveridge takes me to task for stating in the early part of the book that in my opinion scientific methods of collecting animals were out of date and that I had a new idea for collecting. Later on he quotes me as employing all the time-honored methods and of shooting promiscuously although I had stated that "we went not to shoot."

I particularly desired not to, and in fact did not, disclose in this popular work the scientific methods of collecting which I did employ. Loveridge is therefore at a disadvantage in trying to criticize them.

We did shoot at hawks frequently for sport and it was also necessary to prevent them from trying to steal our stuffed specimens from the drying boards, which they not unnaturally imagined to be real full-blooded animals.

Our primary object was to study the animals in life and any one who compares our scientific reports with those of previous expeditions will see that they are based upon a study made from an entirely different point of view.

(15) Loveridge states that "Animal Treasure" does not bear out a claim made for me by one of the reviewers that it is evident that I love animals.

I personally have never put forward such a claim. I do not love animals as animals, although I am intensely interested in them. Upon the other hand I abhor cruelty in any form.

Loveridge quotes two instances from the book in which reference is made to an adder and frogs being drowned in alcohol and points out that a humane collector would have chloroformed his victims. In reading a popular book the public does not like being led through an involved description of detail and therefore the method of dispatch of the animals in question was not fully described as it would have been had I been writing from a purely scientific point of view.

In fact, all my herpetological specimens (which Loveridge calls "victims")

were first of all chloroformed before being "received into the all-absorbing alcohol."

(16) Loveridge seeks to prove that my views upon Mission work in Africa are such as to vitiate my views upon the mantis and the spider.

Although it can have nothing whatsoever to do with my merits or demerits as a scientist, Loveridge is quite open to differ from me in his opinion as to the method and work of Missions in West Africa, but there is no ground whatsoever for the statement which he perpetrates that I have "rejected the claims of Christ for myself." This can be nothing but a gratuitous piece of personal offensiveness for which there is no foundation.

(17) "Animal Treasure" claimed that nature in the unspoiled jungle, in the part of West Africa to which I was referring, is far more beautiful than those parts of it in which the white man has settled. Loveridge occupies this section of his criticism by expressing a contrary opinion. He is quite at liberty to do so, but it is not a helpful basis for scientific criticism.

(18) Loveridge states that I have caused incalculable injury to natural history by disseminating false information which is and will be quoted far and wide.

I thank him for the compliment as to circulation, but I maintain that substantially, with the one exception which Mr. Loveridge has pointed out, "Animal Treasure" is accurate.

(19) Loveridge summarizes his conclusion by stating that I am not a scientist. Evidently he has arrived at this conclusion from reading a popular book and in fact of prejudging a matter on insufficient material, a fault of which he accuses me in his criticism No. 16.

I hope that if only as a matter of courtesy he will read the scientific reports of the expedition in question.

(20) Loveridge says: "We all make mistakes."

It is satisfactory to know that with his last criticism at any rate we are in mutual agreement.

The merit of Loveridge's attack on Mr. Pope and Mr. Adamson arising out of their review of "Animal Treasure" may now be judged in the light of the criticisms which he has made concerning that book. I would repeat that the book has never been claimed by its author as a purely scientific work nor was it reviewed as such by Mr. Pope and Mr. Adamson; it is a popular introduction to the public of some of the wild life of West Africa.

The intelligent questioning of new facts reported by collectors is very beneficial, making as it does for more careful future observation and more detailed and meticulous notes. The sweeping and uncompromising criticism which assumes that every original affirmation must be either an exaggeration or frankly untrue if it is not already known to the critic, even though the critic has little or no field experience of the area under discussion, tends to make abortive any serious endeavor to extend our real knowledge of natural history.

LEAD SHOT: ITS DANGER TO WATER-FOWL[1]

By THOS. L. G. OSMER

MINNESOTA DIVISION OF GAME AND FISH AND UNIVERSITY OF MINNESOTA

EACH year since the first fowler in America fired his muzzle-loading shotgun at a duck, water-fowl areas throughout the nation have been increasingly peppered with shot. Each year produced more and more duck hunters who, instead of using the old muzzle-loader, developed the modern double, repeating and automatic shotguns with smokeless powder and high velocity shells. Thus to-day, during the season, every duck flying over a blind is usually accompanied by a shower of shot, whether he is in gun range or not.

If a duck survives a hunting season, the chances are becoming increasingly greater that he will pick up, on his feeding grounds, enough lead shot to cause death by lead poisoning. This grave danger is not seasonal, like hunting, but is a threat whenever the duck is feeding. Nor is the shot covered up by sediment as rapidly as one would hope, but usually remains available to water-fowl for many years. It has been experimentally determined that the ingestion of six No. 5 shot by a duck is fatal, and even two or three shot are often fatal.

Lead poisoning of water-fowl is not new. In 1842 a paper was published in Berlin on the injurious effects of lead upon animals. In the February, 1894, issue of *Forest and Stream* Dr. George Bird Grinnell, famous hunter and naturalist, published an article on lead poisoning of water-fowl in Texas and North Carolina. In 1919, Dr. Alexander Wetmore investigated western duck sickness and lead poisoning in the water-fowl of the great marshes of the Bear River in Utah. In addition to other valuable information he discovered that six shot fed to a duck were always fatal. A partial bibliography of no less than 47 titles on lead poisoning of water-fowl is on file in the United States Biological Survey at Washington.

Many water-fowl refuges in the state of Minnesota and doubtless throughout the nation were old and much-hunted duck lakes long before they were declared refuges. While such a refuge affords safety from hunters it may be a veritable death-trap for water-fowl because of the presence and availability of the old lead shot on the bottom. This potential death by lead poisoning, while ever present, is greatly increased during the hunting season because water-fowl tend to concentrate on refuge areas during this period. Furthermore, death by lead poisoning becomes an ever greater danger if refuge lakes are located on areas where there is a scarcity of native gravel suitable for consumption by water-fowl. Grit is as essential and vital to water-fowl as food and water, and if the grit is abundant and readily available it is eaten in liberal quantities and passes through the digestive systems more rapidly. Under conditions of grit scarcity the grit may be conserved and ground over longer periods of time. When grit is ingested in abundance the lead shot picked up also have greater opportunities of being passed through the digestive system before their poisoning effect can be felt. Apparently a duck does not discriminate between a lead shot and a piece

[1] Paper No. 412, Miscellaneous Journal Series, Minnesota Agricultural Experiment Station. Cooperative investigation supported by Division of Entomology and Economic Zoology, University of Minnesota, and the Minnesota Conservation Department, together with aid from the Work Projects Administration (Project No. 665-71-3-69).

of granite or quartz of the same size. If it did, lead poisoning, the most serious disease problem in water-fowl management to-day, would not exist.

With the foregoing in mind it seems to be very poor water-fowl management to turn old duck-shooting areas into refuges without first determining the relative amounts of shot and gravel that are available to water-fowl. Based upon this premise an investigation was begun to examine, methodically, lake-bottom samples and to study the availability of lead shot and gravel to water-fowl, the chief interest being lead shot.

The samples in the study were taken either with a Peterson dredge, such as is used in limnological work, or with a post-hole digger. For each sample the amount of bottom surface covered was one square foot. Precautions were taken to sample only the five to six inches at the surface of the lake bottom, that area in which the water-fowl are most accustomed to feed.

As the ice ranged from three to 30 inches thick a crew of WPA laborers was obtained to assist by cutting the holes through the ice. The lakes studied were either transected at right angles by two lines of holes or a series of holes was made around the entire lake as close to shore as possible.

This method was used on all the duck lakes surveyed except Heron Lake. Because of the large size of this lake—20 miles long and one mile wide—it was planned first to take samples from several areas that were most heavily hunted and then to take samples of the entire lake in the manner in which the other lakes were surveyed. However, circumstances prevented completion of these plans and only four heavily shot areas were surveyed with a total of 36 samples. Probably a more accurate picture of lead-shot conditions on Heron Lake could have been made if 100 or more samples could have been taken.

A rough map was drawn of each lake, and the number and location of each sample was recorded when it was made. Each sample was given a tag indicating the name of the lake, number of the station, depth of water and type of bottom. By so doing it was possible to determine, roughly the distribution of the shot over a given area or the entire lake. It was found that the shot was more or less evenly distributed on the bottoms of those lakes examined. The size of the area over which a single charge of shot is scattered is so great that a rather general distribution of spent shot over a lake bottom is assured. Tests under field conditions showed that the shot from a 16-gauge high velocity shell may carry nearly 300 yards and that the pattern may be spread over a distance of 48 yards.

After the samples were washed through special sieves in the laboratory the residue of shot, seeds, gravel, small snails, clams, etc., was dried and separated into vials for further study. In those samples containing lead the shot was counted and the amount was added to the corresponding tag. The duck lakes surveyed represented both those closed to hunting and those on which hunting still occurs. By so doing it was possible to make a comparison of lead-shot conditions in the two kinds of lakes.

In three lakes in the Carlos Avery Refuge in Anoka County, Minnesota, much of the lead shot from past years' shooting still lies within a few inches of the surface of the lake bottom and is undoubtedly available to feeding water-fowl. In two of the lakes, Little Coon and East Twin, at the time of the study no shooting had been allowed for five years, and, in spite of this, shot were recovered from the bottom samples at the rate of one shot per 3.5 square feet, and one per 1.66 square feet, respectively. These averages are based upon 28 and 25 samples.

The third lake within the refuge, West Twin Lake, was protected from all shooting for four years, but had been opened to hunting for one year at the time the work was done. Here 27 samples yielded 12 shot or an average of one per 2.25 square foot, a figure quite comparable with these from the other two refuge lakes.

Three nearby lakes on which ducks are hunted were studied for comparison. They were Boot Lake, Rice Lake and Tamarack Lake, all in Anoka County within three miles of the Carlos Avery Refuge Lakes. The incidence of shot varied from one per 1.25 square feet in Rice Lake to one per 8 square feet in Boot Lake, but the average for these three lakes, all continuously open to hunting, was one shot per 2.04 square feet. The distribution of the shot over the six lakes was general.

To make matters worse, there is a very marked scarcity of gravel in the Carlos Avery Refuge lakes. In fact, because of its geological formations the major portion of the entire county has very little native gravel available or suitable either to water-fowl or upland game. It seems logical to assume that any duck lake, refuge or otherwise, which has a very marked deficiency of gravel for water-fowl but at the same time has lead shot easily available is that much more dangerous to water-fowl, and the total amount of gravel in the 80 samples taken on the three Carlos Avery Refuge lakes weighed but 2.3 grams. Over 37 per cent. of the total number of samples from these refuge lakes were entirely devoid of gravel. Since the average duck gizzard contains two to three grams of gravel, a duck on these lakes would have to cover at least 80 square feet of lake bottom in order to find sufficient gravel for his needs. However, the same duck has but to forage 15 square feet in order to find enough lead shot to cause death by lead poisoning!

Such a condition as that found on the Carlos Avery Refuge lakes *might* be partially remedied by simply distributing gravel of suitable size and kind on the lakes during the winter months. In the spring when the ice melts the gravel sinks to the bottom and is thus available to water-fowl.

Heron Lake, Jackson County, Minnesota, is located about 150 miles southwest of Minneapolis and 10 miles west of Windom. This lake has been a famous water-fowl hunting area for over 75 years. At one time it was one of the greatest canvas-back lakes in the state, but since practically all the wild celery has disappeared very few ducks of this species visit it. To-day it is a favorite mallard lake.

Heron Lake is divided into three parts, the smallest of which is on the north end and is called Duck Lake. The other two make up the bulk of the main lake, and all three comprise an area approximately 20 miles long by one mile wide. The average depth of the portions studied was between 18 and 24 inches. The bottom is hard clay with one to three inches of mud on top. The dominant vegetation is river bulrush (*Scirpus fluviatilis*), which has but slight value as a duck food. About 2,000 seeds of this aquatic plant were taken from only 36 samples. Gravel, suitable for water-fowl, was not scarce, only four out of the 36 samples being without grit. The 36 samples were taken from four different areas that had been hunted most intensively during the past years.

Only one of the four samples taken on Duck Lake contained lead, but this amounted to three shot. Three samples taken from the west side produced a total of four shot. Twelve samples of the 23 taken on the southeast and south sides of upper Heron Lake yielded a total of 46 shot. One of these samples, covering one square foot, contained 11 shot!

The average density of shot on the total area surveyed amounts to 1.5 shot for every square foot of bottom. While this

density is very high, it perhaps would be higher and more general in distribution if the lake were open to public hunting. For many years the entire lake has been leased to individuals and groups of hunters who shoot over definite areas and prevent the general public from entering their private domain.

The bottom of Heron Lake would keep lead shot easily available to water-fowl for many years to come, even though a shotgun were never to be discharged over it again. The rate of deposition is very slow, as revealed by a thin covering of mud. These two factors, especially when combined with heavy hunting, constitute a great lead-poisoning hazard for water-fowl.

Very little can be done to lessen the danger of lead poisoning on a lake of this type. To stop the increase of lead by closing Heron Lake to hunting would be futile because the water-fowl would only concentrate on it during the hunting season, causing a more severe increase in lead poisoning mortality than already exists. Such a procedure would also meet a tremendous opposition by those who hunt the lake. Such drastic measures as trying to cover the lead or remove it would not only be economically impractical but would destroy valuable water-fowl foods for several years to come.

Most water-fowl lakes in Minnesota may be classified into three major groups: tamarack-bog lakes, like Rice and Tamarack lakes in Anoka County; prairie lakes, like Heron Lake and those on Carlos Avery Refuge; and river-lakes, like those common along the Minnesota River. The lakes surveyed to date fall into these three classes and are typical of each class.

The river-lakes surveyed for lead shot and gravel available to water-fowl included five large lakes on the Minnesota River, owned or leased by private gun clubs. The Minnesota River Gun Club, which owns one lake, is located across the river from the west end of Fort Snelling, in Dakota County. The Long Meadow Gun Club controls two lakes, and is located south of Minneapolis, in Hennepin County. The Benz Club owns two lakes, and is located on the south side of the river and a few miles downstream from Shakopee. The level of these lakes is usually maintained by dams and springs.

The data reveal that of the three major classes of duck lakes the river-lakes have the least lead available to water-fowl, an average of one shot per 2.97 square feet in the 107 samples from three areas studied. This fact may be due chiefly to three factors. First, river-lakes in general have the highest rate of deposition of any type of duck lake because of the annual flooding of the river; thus the shot is more rapidly covered up and made unavailable to ducks. Second, practically all the hunting on these three areas is pass shooting; thus less shot falls in duck-feeding areas on the lakes. Third, these particular lakes have been leased or owned by private parties for many years, and therefore the number of hunters per season and per day is limited. Thus less shot is scattered over the feeding grounds for the ducks to pick up.

If these river-lakes were open to the public a far greater incidence of lead shot would undoubtedly occur, as all three areas are within 30 miles of the Twin Cities. The data reveal also that the river-lakes have more gravel available to water-fowl than the other types of duck lakes surveyed.

In addition to the lead shot recovered from the bottom samples, a total of 24 species of aquatic plant seeds were found. The number of species in each lake ranged from two to eleven. Such important water-fowl foods as *Sagittaria, Scirpus, Najas, Polygonum, Zizania* and nine species of *Potamogeton* were identified.

The number of shot found in this study show how widely distributed and easily

accessible to water-fowl lead shot are, and how important is the need of control. Professor R. L. Dowdell, of the School of Mines, and Dr. R. G. Green, of the School of Medicine, both of the University of Minnesota, have devised an alloy of magnesium and lead to be used in the manufacture of shot. Shot made of this alloy disintegrates rapidly in water due to the action of magnesium. Even if these small particles of disintegrated lead are picked up by a duck they are not retained in the gizzard. Whole pellets eaten by the bird decompose into small fragments, which are almost completely eliminated in 48 hours. This non-toxic shot in no way affects the pattern of a modern shotgun. It appears to offer an early solution of the problem. The data here presented emphasize that when the commercial production of a non-toxic shot becomes feasible the change should be made even if compelling legislation is necessary to assure it.

Little can be done about the shot that already lies on the bottoms of many thousands of duck lakes throughout the nation; therefore, in conclusion, it seems that setting aside an old hunting area for a duck refuge, as has often been done, is not wise if the bottom of that particular lake has in it considerable lead shot available to water-fowl. To allow ducks to concentrate during the hunting season on a refuge full of available shot is comparable to turning broods of quail or pheasants into coops contaminated by disease. Before any water-fowl area previously used for duck shooting is declared a refuge, a thorough survey and analysis, of at least the feeding grounds of that area, should be made to determine the relative amounts of lead, gravel and food available to water-fowl.

EDUCATION OF MEDIOCRE PERSONS

THERE are those who believe that it is to-day too easy rather than too hard for mediocre persons to be carried forward into careers which demand something very different from mediocrity. Institutions of higher education have numberless fellowships and assistantships at their disposal. It is not hard to find government help these days; and a recent summary made by the National Research Council lists some 450 research appointments made annually by industrial organizations for work to be carried on outside their own laboratories and with only incidental reference, if any, to their own immediate interests. . . . Only in a few strong professions, notably medicine and law, and the older branches of engineering, can it be said that possession of a degree to-day necessarily means anything. Elsewhere, all too often, a degree as such may mean literally nothing. All over the country teaching and other vacancies are being filled by degrees, not by men or women, the appointing bodies accepting the diploma as a substitute for the tiresome process of really finding out something as to the professional and personal qualifications of individual human beings. Sometimes the situation presents curious anomalies, as in the fine arts, where the possession of a Ph.D., however much it may imply as to scholarly knowledge, all too often reflects the absence of creative interest and capacity on the part of the possessor.—*Report of the President of the Carnegie Corporation of New York.*

COLLECTING METEORITIC DUST

By Dr. H. H. NININGER

CURATOR OF METEORITES, COLORADO MUSEUM OF NATURAL HISTORY

FOR more than a century sporadic efforts have been made to collect meteoritic or cosmic dust which is assumed to be sifting down through the atmosphere as a result of the frictional destruction of smaller or larger meteorites which are constantly bombarding the earth. There have been several instances in which matter, thought to be of this origin, was collected. Two of the sources were the sea-bottom oozes and the arctic snows. Also, there was the case of Professor Maud Makemson, now of the department of astronomy, Vassar College, who collected dust in pans or on sheets placed on towers or other suitable locations. The material was questionably identified as of cosmic origin.

The writer has made many attempts to collect this material during the past ten years, but only recently has he met with success. On the assumption that considerable portions of meteoritic matter would be magnetic, he, in September 1938, tried the experiment of collecting by means of a magnet, at the exits from down-spouts which carry off the water from roofs. This proved to be a fruitful source of a heavy, slaty-gray dust which gave a positive nickel reaction. Microscopically, the material was found to be composed of many irregular particles among which are found multitudes of minute spherical globules, many of which are highly magnetic, so much so that the majority of them constantly cluster together in aggregates of a dozen or more.

The average diameter of those spheres measured was about .09 mm, but it is believed that the major portion of the smaller globules had been lost from this sample and that the average will finally be determined as considerably smaller.

The samples taken were from various types of roofs including wood shingles, composition shingles, slate, tile and galvanized iron. Oxide scale was often found to contaminate the dust. This could be and was readily removed from the samples by reason of its strikingly different appearance.

Our chemical tests were made by four independent authorities. Two spectroscopic analyses were made one of which was by Dr. Arthur S. King, of Mt. Wilson Observatory. Nickel was prominent in all of the reports.

Experiments have proven that there is a magnetic constituent of coal smoke which may pollute the collections made by our method, but the particles from this source are of a lighter color, a lower specific gravity, less magnetic and contain no nickel. Such pollution can also be avoided by collecting from roofs which are remote from the sources of coal smoke. Our collections were made by the use of an alnico magnet supplied by the General Electric Laboratories. In order to prevent nickel contamination from the magnet it was wrapped in a rubber jacket while collecting.

Collecting from roofs has the dual advantage of benefiting by the constant catching and concentration of the fall and also permitting a crude measurement of the rate at which the material accumulates on a given area. Each shower or melting snowfall washes off the accumulation that has arrived since the last previous washing, so that regular collections after each shower supply us with quantitative data. All of our collections are admittedly very tentative as yet, but they indicate that the final results will be of

the order of several thousand grams per square mile annually. If figures of this order are finally proven correct they are quite revolutionary indeed when contrasted with statements in text books in astronomy and geology which allow for an increment of only 10 to 100 grams annually on a square mile of surface.

Much careful research yet remains to be done along the lines of refining the methods of collecting, of analyses and separation of meteoritic from terrestrial dust, of seasonal and geographic distribution of the fall, etc. Years must be devoted to the task, but the final results are of profound importance to astronomy and geology, as well as to meteorology and meteoritics.

The questions naturally arise, if such quantities of meteoritic matter are arriving on the planet why should the soil not be very rich in nickel and why should not we be knee-deep in meteoritic dust. The answer to the first is that nickel rapidly leaches out of oxidized meteorites, as proven by the writer.[1] To the latter question we reply that the surface of the soil is so churned and altered by the ordinary forces of weathering that the most scrutinizing search would be necessary to find even a trace of a rain of spatial matter, even though in the course of a million years it might amount to a layer several inches thick. A layer of about the thickness of ordinary paper would accumulate in a period of a thousand years according to our very tentative calculations.

The dust with which we are dealing has been collected by several methods other than that described. A vessel was anchored to a mast made fast to the top of a tree on a remote mountain top at an elevation of about 11,000 feet and left for seven months. Ice was melted from the surface of a mountain lake. The rough bark of trees was searched by means of a magnetic device. A magnet was floated from a pilot balloon for six hours in a 20-mile wind over a snow-clad mountain. For seven days air was sucked over powerful magnets by an electric fan on the top of a high tower. In all cases the same kind of material was collected, but in immeasurably small quantities.

We found by experiment that our nickel-containing dust is of high specific gravity and that it falls through the air at a rate of about 300 feet per minute. This clearly demonstrates that the most effective methods of collecting it must be devices which catch it in its descent and concentrate this catch. It is here that the eave-trough functions rather efficiently.

[1] See *Amer. Min.*, Vol. 23, No. 8, August, 1938.

PHILANTHROPIC CONTRIBUTIONS IN 1939

THE record for the year throws no new light on the question as to whether the total annual amount of philanthropic contributions is likely to rise or fall. On the other hand, it does confirm the impression that the base of supply is steadily widening. It is significant that a Masonic body in Ohio is contributing $50,000 a year for research in mental hygiene. It is significant also that the human as well as the economic problems of modern housing are being attacked by federal, state and municipal authorities, by two younger foundations, the Ford and the John B. Pierce, as well as by certain of the older ones, and finally by real estate and insurance interests, notably by the Metropolitan Life Insurance Company, which is investing some $65,000,000 in a housing development in New York City.—*Report of the President of the Carnegie Corporation of New York.*

BOOKS ON SCIENCE FOR LAYMEN

CONSERVATIVE CONSERVATION[1]

THIS is a conservative book on conservation. And in that statement there is more than meets the eye. One of the interesting discrepancies of life and language in our time lies in the fact that many of the people whom we call conservatives have not yet become conservationists. This of course is because too many of them are trying to conserve a way of living which was one of the chief causes of the depletion of our natural resources. The problem is to get them busy on conserving the physical basis of all wealth. Otherwise, the things for which they now contend will soon have little meaning.

The present volume is a good inventory of the assets we have to conserve. It is attractive, clearly written and follows the prevailing pattern of approach. This pattern is that of a separate attack on each phase of conservation if and when it begins to assume a pretty immediate economic importance.

The book is sparing in its condemnation of past events—which is just as well since there is no point in chasing water over the dam. It is equally sparing of suggestions regarding social and community readjustments which will have to be faced before we are through. Such suggestions do not always make palatable reading if one is trying to re-educate those whose cast of thought is conservative. No school board is likely to buck at adopting this as a text, and certainly if a generation of young people becomes familiar with its contents, we shall be a long way ahead on the road towards a better America.

Each of the four specialists has treated the problem with which he is professionally familiar. In order, the four sections are: Soil and Water; Forests, Parks and Grazing Lands; Wildlife; and Mineral Resources. A really surprising amount of information is compressed into each section. The nature and extent of each resource group is set forth, and a good account of the manner of its depletion is given in each instance. Technological measures for arresting this depletion are described, and some legislation recommended. There is less offered in the way of remedy in the excellent section on "Mineral Resources" than in the others. This is, after all, an extremely hot potato. If the author gets the facts before the American public he has probably done his share for the present.

The section on "Wildlife" is in some ways the liveliest of the lot, not only because of its style and the nature of its material, but because of the glimpses of an ecological point of view which is too rare in other parts of the book. For whatever else it may be, conservation is certainly applied ecology.

The section on "Forests, Parks and Grazing Lands," like that on minerals, has its data well organized. This of course is in keeping with the alert, industrious and realistic tradition of American forestry. The problem of grazing is dealt with here, doubtless because the Forest Service happens to have been "one of the greatest herdsmen since Abraham." But one could wish, with grasslands originally occupying over 40 per cent. of the nation's surface, that they might have received more extensive treatment than the arrangement of the book has allowed.

The section on "Soils and Water" is essentially agricultural in its approach. It tends to emphasize the mineral rather than the biological aspects of the soil. And it is more concerned with practical operations than with the broader problem of land use, which might very well have afforded the basis for a unifying treatment which is absent in the book. In fact, it may be questioned whether

[1] *Conservation in the United States.* By A. F. Gustafson, H. Ries, C. H. Guise and W. J. Hamilton, Jr. Illustrated. $3.00. 1939. Comstock Publishing Company.

the authors have not gone too far in their efforts to be practical, concrete and non-controversial, and to avoid seeming theoretical. For there is, after all, a unifying theoretical basis for the whole problem of conservation. It can be expressed in a variety of idioms. These range from the mathematical concepts of Haskell (*Ecology* 21 (1) : 1, 1940), through the operational terms of the student of plant and animal communities and the culture pattern concept of the anthropologist, to the dictum of the artist that an ugly landscape is a diseased landscape.

It is of course essential that the American people have access to the accounting records of their capital wealth. These are the dispassionately presented figures. But accounting is a matter of relationship as well as record. And it is more important than ever to-day that the numerous individuals and agencies interested in particular aspects of conservation—floods, water supply, fish and game, forestry, grasslands, minerals, soil and levels of human living—realize that they are all working on facets of the same problem. That problem is the sane and permanent relation of man to the landscape of which he is part. He has become a major geological influence and the custodian of evolution.

The clear statement of a theory can, at times, be an exceedingly practical measure.

PAUL B. SEARS

EFFECTS OF DIETARY DEFICIENCIES[1]

DR. PRICE'S thesis may be summarized in a few words. Tooth decay is a result of civilization and is due to the fact that civilized man has discontinued using, in their native states, those foods which savage man had long ago established as requisite to normal body development. Modern methods of food purveyance have robbed us in great measure of two very important food elements, vitamins and minerals. Modern nutritionists must compensate for this loss by food additions in concentrated form, but this replacement does not adequately take the place of those original foods which were provided by nature.

To those who are versed in dietetics this may sound prosaic and self-evident. But the charm of Dr. Price's book is found not in the proving of his thesis so much as in the description of his method. He carries us into a high valley in the Swiss Alps where modern civilization has scarcely penetrated and compares the results of his dental examinations here with those in other parts of Switzerland where motor highways have been put through and the natives no longer depend primarily on rye bread, beef, lamb, cheese and other dairy products for their sustenance. In succession he carries us to remote islands off the coast of Scotland; Eskimo habitations and North Canadian Indian villages, too remote from "store food" to be influenced thereby; Central Africa; Melanesian and Polynesian tribes scarcely in contact with the white man's commerce; Australian aborigines and remote Peruvian Indians in their mountain fastnesses. In each locality he compares the dentition of those groups which have been scarcely touched by contact with civilization with those of the same races among whom commerce has resulted in some degree of change to the white man's diet, including white bread, canned foods, and the like. In every instance he discovers deterioration in the teeth and, as a rule, underdevelopment of the jaw, palate and contiguous bones. Abundant photographic illustrations provide confirmatory evidence.

An outstanding example was his study in one of the Pacific Islands. Until the World War, copra was cheap and Island dwellers lived on native food. Suddenly

[1] *Nutrition and Physical Degeneration. A Comparison of Primitive and Modern Diets and Their Effects.* By Weston A. Price. Foreword by Ernest Albert Hooton. 134 figures. 431 pp. $6.00. 1939. Paul B. Hoeber, Inc.

the price of copra rose to four hundred dollars a ton. This was paid for in 90 per cent. white flour and refined sugar and 10 per cent. cloth and clothing. Dental decay made its appearance for the first time. When, after the war, the price of copra dropped to four dollars per ton and the trading ships no longer called, tooth decay stopped.

There is much in this book besides the foregoing, which some might consider self-evident. Dr. and Mrs. Price have been to out-of-the-way places, which the white man rarely reaches. This was an essential part of their program. The description of tribal customs and taboos makes the volume a travelogue of great interest not only to students of dietetics but to all whose interests include the habits and customs of mankind in all parts of the world.

Although the volume may be read with profit there are points which are subject to criticism. Dr. Price has carefully studied the oral cavities of the inhabitants of those remote regions. He is a dean among American dentists, and none would question his findings. But in his conclusions he goes much farther than the observations warrant, attributing both physical and moral deterioration and demoralization of the white man to present-day dietary deficiencies. At a time when a Lombroso's stigmata of degeneracy are passing into the discard, he presents a new series of stigmata, summarized in under-development and mal-development of the bones of the middle part of the face. He presents confirmatory evidence in his study of modern criminals, but very little in the way of comparison with non-criminals or normal controls. Although reason tells us that there may be much to what he says, his conclusions are not justified by the evidence presented. Unfortunately, Dr. Price presents his conclusions, as generalizations, in the introductory chapters. As a consequence a critical reader is apt to become slightly dubious after the first few pages.

One who starts his reading at chapter three will discover a most interesting travelogue with a discussion of the effect of the modern dietary on tooth decay and certain facial deformities, which should be provocative of real concern. In the concluding chapters one will find generalizations which are at least food for thought.

WARREN T. VAUGHAN

ANIMAL LIFE IN WINTER[1]

IT is a lamentable fact that naturalists seem to prefer the cloistered library or fireside during the winter months and do not rouse from their lethargy until the first red-wings pronounce that spring is at hand. Then there ensues a mad scramble to make for the fields and woods, to study animals during their altogether too brief reproductive period. With the approach of cold weather outdoor science is soon forgotten and the field notebook, camera and collecting kits are laid aside until another spring.

There is no longer reason for this winter lassitude. Dr. Morgan's "Field Book of Animals in Winter" has opened an entire new vista, previously known to a privileged few. Her scholarly account of the winter habits of animals generally, from the sponge colonies of swift-flowing brooks to the dormant woodchuck in his subterranean chamber, should prove of interest to the professional biologist and the layman alike. No longer can one excuse himself from winter field work by stating that there is nothing to see nor study.

The volume sets forth in some detail the devices used for meeting the inhospitable winter season and how animals migrate, either from the tree-tops to the leaf mold below, or shun completely the snow and ice by retiring to more temperate climes. The subject of hibernation is treated adequately, and an able discussion is set forth on winter com-

[1] *Field Book of Animals in Winter.* By Ann Haven Morgan. 16mo. 283 illustrations. 4 colored plates. $3.50. 1939. G. P. Putnam's Sons.

munities of land animals and the seasonal changes in fresh water and its animal inhabitants. Nineteen chapters are devoted to the fresh-water sponges, hydras, flatworms and planarians, rotifers, bryozoans, annelids, leeches, crustaceans, insects (both land and aquatic) spiders, molluscs and the vertebrates. The many illustrations from the author's camera and facile pen are guarantee enough that she knows the animals of which she writes so well.

In a volume of this magnitude, errors obviously are inevitable; the wonder is that there are so few. The author (p. 365), quoting Benedict, states that woodchucks may actually gain weight during hibernation. It has long been established that, *under natural conditions*, all hibernating mammals lose considerable weight. On pages 25 and 427, the red squirrel is said to hibernate, although it is said not to hibernate on page 465. The latter statement is correct. On page 431 we read that hay has been found in the winter burrows of woodchucks, thus implying that they store food, which is not true. The star-nosed mole does not mate in November (page 442) but has a breeding season similar to that of other moles, in the spring. *Sorex cinereus personatus* (p. 443) should read *Sorex cinereus cinereus*. The marten, like many other mustelids, exhibits delayed implantation and mates in late July or August, but never in January (page 453). The muskrat house is not "a dome of mud overlaid with cat-tail stems and weeds" (page 472), in fact, little mud is used in its construction. Several plates in Chapter 25 should be credited to the *Journal of Mammalogy* and not the *American Journal of Mammalogy*. While Cox has shown that the snowshoe hare emigrates, such movements are not comparable to the great lemming migrations of Europe (page 477). Mild winters are not particularly inducive to breeding; it is questionable whether cottontail rabbits breed the year round where winters are mild (page 478). But these are all minor errors, and do not detract in any measure from the value of this book. Some might wish for a plate or two of tracks; a feature which would add to the interest of winter hikes.

Every nature lover, whether he be a professional zoologist or school child, will profit from reading this book. It should find a place in every school library.

W. J. Hamilton, Jr.

TREES AND MAN[1]

When one realizes that the continents were carpeted and forested for millions of years with mosses and ferns, or fern-like vegetation, a number of speculations come to mind. One of these is; what forms of animal life would now stalk the earth (or creep over its surface) if the seed plant had never evolved? Would the appearance of Man have been possible, or having taken his place with animal life, what would be the present status of Man if there were no fruit-bearing or wood-producing plants? How could Man have adapted himself to a life where only ferns or fern-like trees were the dominant vegetation? Certainly the entire physical, physiological, psychic and economic history of the organism known as Man and his present-day institutions would be vastly different if only these simple plants provided his food and materials.

Pertinent to such a question one might speculate a little further and inquire into what Man's present status would be if only plants with seeds borne in cones (Gymnosperms) had evolved. How different would be the food problems of Man to-day; our farm problems (if any); our trade agreements on foodstuffs; our diet, if we had no fruit-bearing plants (Angiosperms) nor the multitudinous substances obtained from the seeds of such plants (either directly or indirectly).

One of the achievements of Lamb's re-

[1] *Book of the Broadleaf Trees.* By Frank H. Lamb. Illustrated. 367 pp. $3.75. 1939. W. W. Norton and Company.

cent book lies in the sharp realization brought to the reader of the absolute importance of broad-leafed Angiosperms in human affairs. Described as a "treasury," this book quite meets all that is implied by the term. In what one might call a Van Loon manner, the author has woven together such an amazing variety of information that the reader who naturally assumes that he is going to learn something of trees discovers that he is, at the same time, learning pertinent facts about geography, geological history, human customs and habits in distant parts of the earth, the qualities and uses of woods and the genealogy of trees. All this and many other kinds of information are so well presented, integrated and developed that the account takes on the atmosphere of a plot. Consequently, it is likely that when one reads the book from beginning to end a climax is expected—only to find that the drama of "Broadleafia" is far from complete and is a moving and unfinished story.

The history is punctuated by well-chosen arboreal verse, which is very artistically used. In fact, the book could be considered a good companion volume to the Sidney Lanier anthology, "Poems of Trees." Thus the work meets the interests of the botany student, the worker in woods, the student of history and economy, the poet and the general reader. Figures, percentages and statistics there are a-plenty, but these are neatly used and serve only to make statements convincing and to help one realize in a factual way the enormous economic and sociological importance of trees. The minutia, the innumerable details, the references to happenings in Australia, the distribution of a species in Oregon or the migration of trees from the Orient are also dealt with so as to impress the reader with the thoroughness with which Lamb has traveled, read and observed.

In the first chapter the author presents a clear, if much telescoped, picture of the origin and development of broad-leafed trees and their successful dominance (eventually) over the primitive and less adaptable evergreens (the conifers). A geological time chart or tree calendar assists in illuminating this picture and in tracing the broadleafed trees from *Caytonia* in the Jurassic through six epochs of geological time. A map of the world inside the cover and another of North America alone help one to visualize the present distribution of the broadleaf forests (involving some fifty different species). While emphasis is placed on the woods of North America the scope of the book is definitely world-wide so that there is a chapter on "North American Broadleafia" and "Broadleafia Abroad" as well. In the latter chapter the distribution of many kinds of trees is discussed somewhat historically, together with the environmental factors related to their distribution. Also the importances to Man are consistently brought to the fore.

In several chapters anecdotes and word pictures are sprinkled generously throughout in such a manner that the interest of the reader is never permitted to sag. These features, together with many excellent photographs, make the book very graphic indeed. A few trees such as walnut, beech and oak are given special attention and several chapters are devoted to these well-known and important members of the broadleaf forest.

In a chapter entitled "Woodland Idyl" the reader is pleasantly and almost unconsciously taught some formal botany, interspersed with such vivid descriptions of life in rural America that many will experience a touch of nostalgia upon reading. In a chapter on "Patrician Hardwoods" one of the most interesting sections describes the meaning of maples in the insignia and emblems of various peoples, their importance as ornamental trees or as sources of valuable wood and food, together with an account of the distribu-

tion and dispersal of a legion of species over the earth from Japan and China.

Some bits selected at random from the book will serve to illustrate the great variety of lore included in this (if one may coin a word) philosylvanic treatment. A sprig of elm is placed, even to-day, in the butter churn by European peasants to prevent the bewitching of cream—a rite descended from the tree worship practiced by pagan races. The maple is called a sycamore in England because this tree was used in the early mystery plays on account of its being nearest in appearance to the sycamore scaled by Zacchaeus in Biblical tradition. The English walnut is not English at all but came from Asia Minor via Italy and Southern Europe. The Koala, or "Teddy Bear," which is the only animal that lives entirely on tree leaves and the only one which does not drink water, is a specific inhabitant of the eucalyptus tree in Australia. Gumbo-limbo is a curious tree in Florida, the sap of which is used as a liniment and as a cure for gout. Fifty billions of toothpicks are made from seven and a half million board feet of birch lumber.

For pure esthetic enjoyment there is an Epilogue of verse and poetic prose. Some readers may be disappointed in the brevity of the bibliography and in the fact that the index lists only the common names of the broadleaf trees.

G. W. PRESCOTT

ESSAYS ON SCIENCE[1]

APPARENTLY the world is beginning to realize that there is a strange new force at work, one that perhaps should be both revered and feared. It is called *science*, though the word is used in a great variety of meanings. This recent awareness of the great importance of science has given rise to books on science from many points of view. "Science Marches On" is the latest.

The author adopted a praiseworthy plan "to present science as a whole," presenting particular scientific advances as illustrations of general principles. He regards the accounts of science by scientists as being "generally biased to an incredible degree," and he asserts that "the parts played in the acquisition of knowledge by the esthetic sense, by intuition, and by ethical motive, for instance" are "usually ignored and often violently denied." One can not but wonder what masters of science from Aristotle to Einstein the author has read.

The book itself consists of an introductory chapter followed by nineteen chapters, each devoted to a single general topic, and a concluding semi-philosophical, but rather weak, chapter on "Where Is Science Going?"

The nineteen chapters on scientific subjects are well written and individually interesting, but they do not follow any easily discoverable plan. For example, after an interesting chapter on the origin of written records, followed by one on fire, the author continues with an amazing mixture in "Earth's Fruits." In it he runs all the way from prehistoric use of metals to types of crystals, double refraction of light, polarization, interference figures, crystal analysis and lattice structure, and finally closes with a strange story of a polar continent "Arctis" and a theory of its relation to the formation of coal, asphalt and petroleum. The chapters themselves, on such subjects as "The Origin of Life," "The Idea of Evolution," "The Fascination of Figures," "Pigeon-Holes of Knowledge," "The Mystery of Light," "The Miracle of Musical Sound" and "The Control of Force," illustrate the variety in the book and the lack of clear relationships among its parts.

F. R. M.

[1] *Science Marches On.* By Walter Shepherd. $3.00. 420 pp. December, 1939. Harcourt, Brace and Company.

THE PAN AMERICAN UNION BUILDING—HEADQUARTERS OF THE CONGRESS

DEDICATED IN APRIL, 1910, AND FINANCED LARGELY BY MR. ANDREW CARNEGIE, BUT ALSO BY APPROPRIATIONS FROM THE UNITED STATES AND LATIN AMERICAN COUNTRIES. THIS BUILDING CONTAINS THE COLUMBUS MEMORIAL LIBRARY OF THE UNION.

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THE PROGRESS OF SCIENCE

EIGHTH AMERICAN SCIENTIFIC CONGRESS

La asociación de los pueblos americanos en un congreso científico es la mejor manera de crear entre ellos una sincera amistad—una amistad libre de toda sospecha. Es a su vez la mejor manera de estimular el estudio de numerosos problemas que poseen un carácter peculiarmente americano.

Deberíamos tener presente que los principales políticos, económicos y sociales que han de predominar en el nuevo mundo, pueden implantarse únicamente después de estudiar el carácter nacional, el origen histórico, y les costumbres y tradiciones de los pueblos de este Continente.

The association of the American peoples in a scientific congress is the best way of creating between them a sincere friendship free from all suspicions. It is also the best way of furthering a study of numerous problems that possess a peculiarly American character.

We should bear in mind that the political, economic and social principles which are to predominate in the New World can be implanted only after a study of the national character, the historical origin, the customs and traditions of the people of this continent.

Eduardo Poirier.

This sentiment, so ably expressed at the First Pan American Scientific Congress held at Santiago de Chile in 1908, ever since has animated and given definite purpose to these meetings of scholars from all the Americas. It is especially gratifying at the present time to realize that science in all its branches is able to play a part as a coordinating and stabilizing force among the twenty-one American republics. And we in the United States should regard ourselves as especially fortunate in being privileged to act as hosts to the Eighth American Scientific Congress.

The Eighth American Scientific Congress will be held in Washington, D. C., from May 10 to 18, in response to invitations sent to the governments of the other American republics by President Franklin D. Roosevelt. In a letter to the Honorable Cordell Hull, Secretary of State, President Roosevelt wrote:

> Our debt to the men and women of science defies computation. The generous contributions which scholars and technicians have made to our twentieth century civilization have earned for them a position of influence and respect unparalleled in any other period of the world's history. The path of the scientist and scholar is the path to peace and prosperity which lies open to all nations and all peoples. . . . It is hardly necessary to delineate here the obvious benefits resulting from a meeting of these unselfish benefactors of mankind in an atmosphere of true fraternity such as the Eighth American Scientific Congress offers. I sincerely hope that professional leaders in all of the Americas will avail themselves of this opportunity to share the friendship of their colleagues throughout the Hemisphere.

In a letter to the Secretary of State expressing his deep appreciation of the action taken by the Government of the United States in convening the Eighth American Scientific Congress Dr. Leo S. Rowe, Director General of the Pan American Union, called attention to the fact that in April the Pan American Union observes the fiftieth anniversary of its founding at the First International Conference of American States, which met in Washington in 1889–90, and he wrote that it is especially gratifying that the scientific congress will be held as a part of the program that will commemorate this significant date in the history of the Union, and in the history of inter-American relations in general.

The Eighth American Scientific Congress will be held under the chairmanship of the Honorable Sumner Welles, Under Secretary of State, with Dr. Warren Kelchner, chief, Division of International Conferences, Department of State, and Vice Chairman, and Dr. Alexander Wetmore, Assistant Secretary, Smithsonian Institution, as Secretary General.

The congress is divided into eleven

sections, each of which has as its chairman a member of the organizing committee. The sections are Anthropology; Biology; Geology; Agriculture and Conservation; Public Health and Medicine; Physics and Chemistry; Statistics; History and Geography; International Law, Public Law and Jurisprudence; Economics and Sociology; Education. Each of these sections embraces a broad field, in many cases broader than the title would indicate, and between them they cover the entire field of science.

The congress will be formally opened by President Roosevelt on the evening of Friday, May 10, at the Pan American Union. Registration and the preliminary organization of the sections will occupy the entire first day of the congress, and the definitive organization of all sections will be completed on Saturday morning. A trip to Mount Vernon has been arranged for Saturday afternoon, and in the evening there will be an official reception at the Pan American Union. A motor trip through the springtime countryside of Virginia to the beautiful Caverns of Luray will feature the program for Sunday. The first plenary session of the congress will take place on Monday, followed by the official luncheon tendered by the United States Government to the governmental delegates of the other American republics. The afternoon will be devoted to the business of the various sections. Tuesday will be devoted entirely to meetings of the sections, with a special symphony concert in the evening. Wednesday morning and early afternoon will be

THE PATIO OF THE PAN AMERICAN UNION BUILDING

DESIGNED AFTER THE TYPICAL LATIN-AMERICAN PATIO, WITH A COVERED PROMENADE AND OPEN TO THE SKY AT THE TOP. A SLIDING ROOF, HOWEVER, CLOSES OVER THE PATIO DURING BAD WEATHER. A MAYAN FOUNTAIN, DESIGNED BY MRS. HARRY PAYNE WHITNEY, PLAYS IN THE CENTER OF THE PATIO.

HALL OF THE AMERICAS IN THE PAN AMERICAN UNION BUILDING

THE ROOM ACCOMMODATES BETWEEN 800 AND 900 PERSONS WHEN USED AS AN AUDITORIUM. THE WORD "PAX" INSCRIBED IN THE FOUR CORNERS OF THE ROOM SYMBOLIZES ONE OF THE IDEALS OF THE UNION.

devoted to congress matters. Later in the afternoon the delegates will be guests at a garden party in their honor. Thursday, after a full day of sectional proceedings, there will be held the official banquet of the congress, at which the official delegates will be the guests of the United States Government. The final meetings of the sections will be held on Friday morning, and the final plenary session of the congress will take place the same afternoon. Later in the same afternoon the delegates will leave by river steamer for Old Point Comfort, whence they will proceed by way of Jamestown and Yorktown to Williamsburg to inspect the restorations. Tuesday will be Eighth American Scientific Congress Day at the New York World's Fair.

The Eighth American Scientific Congress is the culmination of an interesting series of events. It was at Buenos Aires, Argentina, on the occasion of the celebration of the Silver Jubilee of the Argentine Scientific Society in 1898 that the first scientific congress of international scope in the Western Hemisphere was held. This meeting achieved such eminent success and excited such favorable attention throughout the South American republics that before adjournment a second congress was planned, to meet at Montevideo three years later. This second Latin-American Scientific Congress convened at Montevideo in 1901; present were 48 official delegates, 79 delegates of scientific organizations and 749 affiliated members. The third Latin-American Scientific Congress was

held at Rio de Janeiro in 1905, the attendance being about 800.

At the closing session of the congress in Rio de Janeiro a resolution was adopted to hold the fourth Latin-American Congress at Santiago de Chile. The congress initiated a significant departure when it stated that the agenda for the fourth congress should include matters of a distinctly inter-American nature. The meeting at Santiago de Chile in 1908 thus assumed a new and comprehensive character. Whereas at the three previous meetings there had been included only Latin-American delegates, the Government of Chile enlarged this basis of representation so as to include representatives from all the American republics, and at the same time the title "First Pan American Scientific Congress" was given to this meeting. There was now manifested a new orientation of the subjects proposed for discussion. For the first time a definite effort was made to limit the discussion to matters of Pan American interest, particularly those concerned with the social, political and economic relations peculiar to the Western Hemisphere.

The second Pan American Congress was held in Washington in 1915 with more than 2,500 persons participating, including almost 100 official delegates from the twenty Latin-American governments, as well as 130 delegates from the scientific societies and institutions of Latin America. The third Pan American Scientific Congress was held in Lima, Peru, in 1924, and the fourth at Mexico City in 1935. The present congress is the fifth Pan American Scientific Congress, or the Eighth American Scientific Congress.

AUSTIN H. CLARK

SESQUICENTENNIAL OF AMERICAN PATENT SYSTEM

THIS year—1940—marks the one hundred and fiftieth anniversary of the enactment of the first United States patent law. On April 10, 1790, President George Washington signed the bill from which the modern American Patent System has gradually evolved. Three years earlier, the Constitutional Convention had given Congress the power "to promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."

When the delegates from the various states met in Philadelphia in 1787 to frame the Constitution of the United States they soon became aware of the need for giving some form of protection to authors and inventors under the new government. Although the delegates, like other Americans of that time, were strongly opposed to monopolies of the sort granted by European monarchs, they voiced little objection to the principle of granting limited monopolies to inventors in the form of patents. The delegates fully appreciated that some type of encouragement was essential to promote inventive genius, and they were equally aware of the resulting benefit to society when such encouragement is given. It is not surprising that they adopted unanimously the Constitutional clause giving Congress the power to promote the useful arts.

Before 1790 our colonies and our states had issued patents. The existence of many different rules concerning patents in the various states and colonies was—to say the least—confusing. An inventor might obtain a patent in one state and be unable to secure it in another. In each state he would have to make special application to the legislature, as there were no general laws concerning the granting of patents.

Soon after the first Congress met in New York City on March 4, 1789, it was besieged with petitions by inventors and

authors—each seeking special acts of Congress granting them exclusive rights. It became evident that neither Congress nor the inventors could be burdened with the uncertainty of a special legislative act in each case, and that a general law providing for patents for inventions was necessary. The first session of the Congress, however, passed without any final action.

Soon after the second session of Congress met, President Washington addressed the members, pointing out the necessity of their giving effectual encouragement to the exertion of skill and genius in producing new and useful inventions. Congress reacted quickly to the President's suggestion and appointed a committee to prepare a patent bill. By April 10, 1790, three months after Washington's address, the bill had been drawn up, amended, passed and approved.

When the first patent laws went into effect in April, 1790, this nation of six million was almost entirely dependent upon agriculture for its existence. Industry played but a small role in the economic life of the country. To-day, a hundred and fifty years later, the population has increased to a hundred and thirty million and the economic picture has completely changed. To-day, America is essentially an industrial nation. Unquestionably there is a direct relation between America's industrial development and her Patent System—the more than two million patents issued in the intervening years bear testimony to that relation.

At first the number of patents issued by this country was small. During the first year the patent laws were in effect a mere three patents were granted. By 1836 less than 10,000 patents had been issued—yet among these were a number

OFFICIAL SEAL OF THE U. S. PATENT OFFICE
SYMBOLIZING AMERICA, AGRICULTURE AND INDUSTRY.

To the Commissioner of Patents.

The Petition of Abraham Lincoln, of Springfield in the county of Sangamon & State of Illinois Respectfully represents.

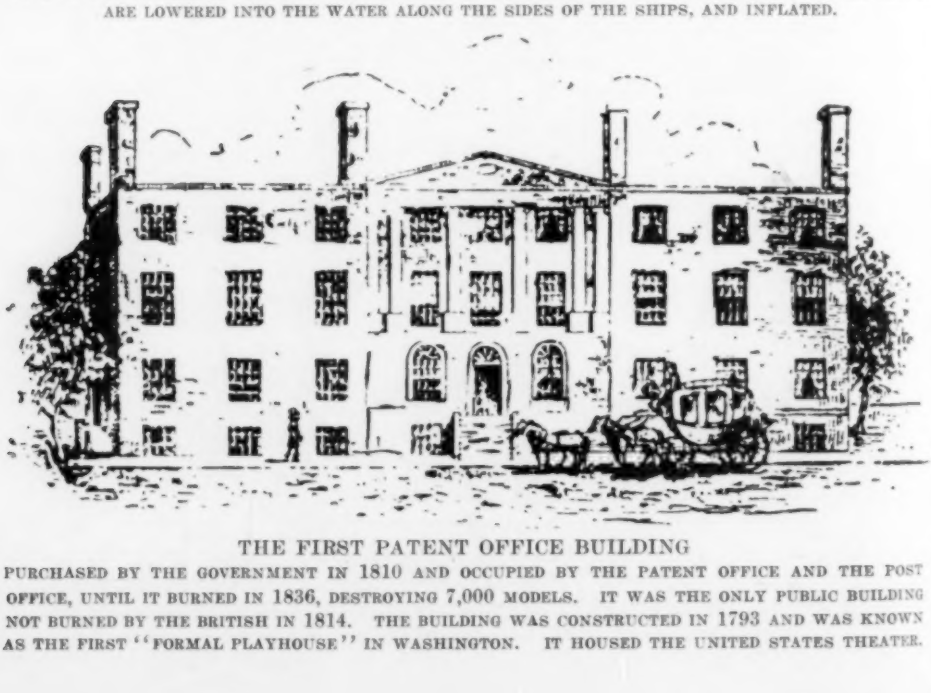
That your petitioner has invented, a new and improved manner of combining adjustable buoyant chambers with steam boats or other vessels which has not, as he verily believes been heretofore used or known, and that he is desirous that Letters Patent of the United States may be granted to him therefor, securing to him and to his legal representatives, the exclusive right of making and using, and of vending to others the privilege to make or use, the same, agreeably to the provisions of the Acts of Congress in that case made and provided, he having paid thirty dollars into the Treasury of the United States, and complied with other provisions of the said Acts.

And he hereby authorises and empowers his Agent and Attorney, Z. C. Robbins, to alter or modify the within specification and claim as he may deem expedient, and to receive his patent; and also to receive back any moneys which he may be entitled to withdraw, and to receipt for the same.

A. Lincoln.

A PATENT APPLICATION OF ABRAHAM LINCOLN FILED ON MARCH 10, 1849

THE FORMER PRESIDENT WAS GRANTED A PATENT FOR AN INGENIOUS ARRANGEMENT FOR ENABLING OVERLOADED VESSELS TO PASS THROUGH SHALLOW WATER WITHOUT DISCHARGING THEIR CARGO. BY A SYSTEM OF SLIDING SHAFTS, ROPES AND PULLEYS, CHAMBERS COMPOSED OF INDIA RUBBER CLOTH ARE LOWERED INTO THE WATER ALONG THE SIDES OF THE SHIPS, AND INFLATED.



THE FIRST PATENT OFFICE BUILDING

PURCHASED BY THE GOVERNMENT IN 1810 AND OCCUPIED BY THE PATENT OFFICE AND THE POST OFFICE, UNTIL IT BURNED IN 1836, DESTROYING 7,000 MODELS. IT WAS THE ONLY PUBLIC BUILDING NOT BURNED BY THE BRITISH IN 1814. THE BUILDING WAS CONSTRUCTED IN 1793 AND WAS KNOWN AS THE FIRST "FORMAL PLAYHOUSE" IN WASHINGTON. IT HOUSED THE UNITED STATES THEATER.

which were to have a vital bearing on our industrial advance. As time went on the number of patents granted increased at a surprisingly rapid rate, and in the last thirty-nine years over a million and a half have been granted. Last year alone over 49,000 patents were issued. The Patent Office staff, which originally consisted of an examiner and three or four clerks, to-day numbers 1,350, of whom 700 are highly trained, scientific experts in the various fields of mechanical, chemical and industrial knowledge. To accommodate all these workers and its equipment the Patent Office requires over eight acres of floor space, occupying one third of the mammoth Department of Commerce building, reputedly one of the largest office buildings in the world.

The purpose of a patent, as envisaged by the framers of our patent laws, was to grant a reward for the invention or discovery of something new, something before unknown, something added to the sum total of human knowledge. The patent not only rewards the inventor; far more important, it encourages him to invent, and once he has been granted a patent the whole world becomes informed of his discovery or improvement. The world can not, without his consent, use the discovery or improvement for seventeen years, but thereafter the public has the full benefit of the device, whose secret might never have been revealed except through the Patent System.

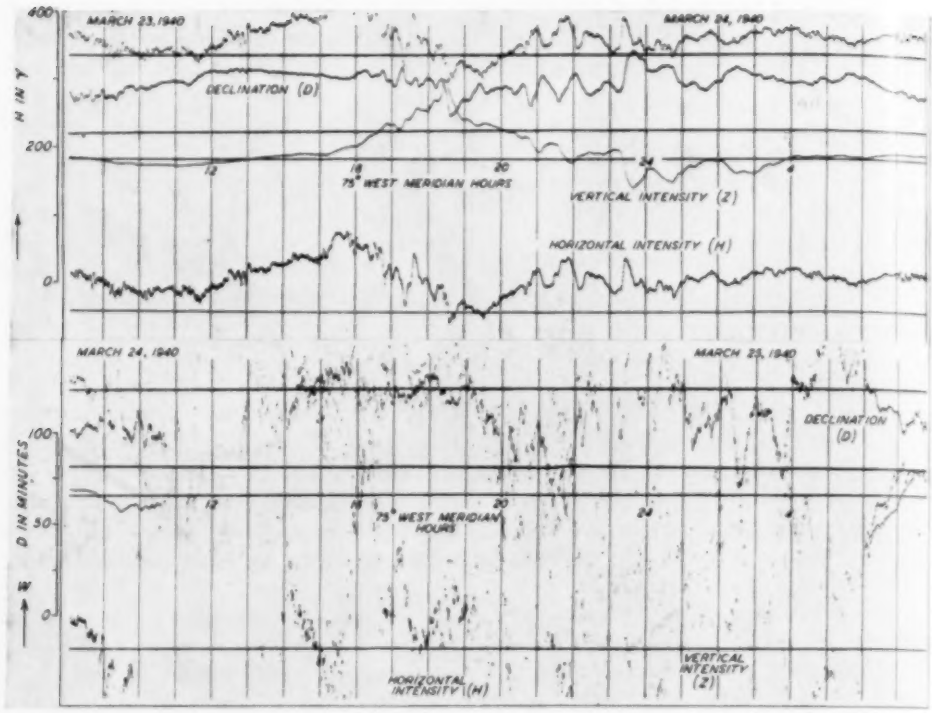
Doubtless some of the ancient civilizations, such as those of Egypt, Assyria and China, produced many useful inventions, capable of higher development and wider adaptation. These inventions were lost to those people, however, and remain unknown to us because they had no patent system for perpetuating the discoveries of each succeeding generation. Our system has preserved the earliest of the inventions made by our own people and those of other lands, and has initiated a process of industrial "evolution." From the first and simplest products of inventive genius more complex and efficient mechanisms and methods have been developed. Every successive improvement and advancement has made still further progress imperative and inevitable. The automobile and the airplane were but crude contrivances in their beginnings. Their inventors and others who have followed them, however, devised additions to the capacity, the safety and the speed of these new carriers. Many of us remember how the automobile acquired, one by one, the accessories that have come to be necessities of its equipment—pneumatic tires, self-starter, hydraulic brakes, electric lamps, etc.

The American patent system has inspired inventions that have served the causes of science, art, education and better living. It gives promise of further and greater benefactions. In these troubled times in which we live we may be particularly grateful to a system which has made and kept this country stronger than any in the world, and thus able to resist any assault on its institutions and its form of government.

CONWAY P. COE,
Commissioner
U. S. PATENT OFFICE

THE GREAT MAGNETIC STORM

THE greatest magnetic storm of the present sunspot-cycle occurred on Easter Sunday, March 24. Apart from the scientific interest of this event to students of geomagnetism, the storm derived much attention because of its effects on the elaborate electrical systems of our modern civilization—service by both telegraph and cable was seriously impaired, high-frequency radio communication over long distances was completely blocked out, and even electric power-systems were affected. Because of the wide-spread popular, technical



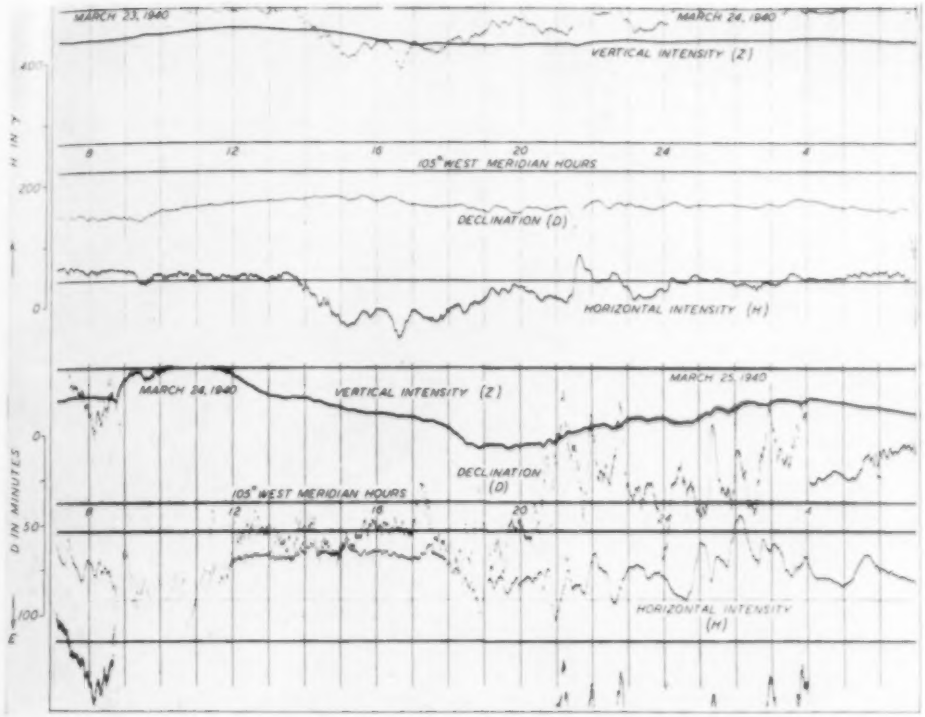
RECORDS OF THE MAGNETIC STORM FROM CHELTENHAM, MARYLAND

MADE AT THE U. S. COAST AND GEODETIC SURVEY OBSERVATORY, MARCH 23–25, 1940. THE THREE ELEMENTS OF THE EARTH'S MAGNETISM—DECLINATION, VERTICAL INTENSITY AND HORIZONTAL INTENSITY—ARE GRAPHICALLY RECORDED BY LINES UPON PHOTOGRAPHIC PAPER. MOVEMENTS UP AND DOWN THE PAPER INDICATE DEPARTURES FROM NORMAL VALUES. SOME MAGNETIC DISTURBANCE IS REVEALED ON ALL DAYS REPRESENTED. THE GREAT STORM BEGINS AT 8^h 50^m, MARCH 24. MOVEMENTS WERE SO VIOLENT AROUND 12^h, MARCH 24, THAT FLUCTUATIONS ARE SCARCELY DECIPHERABLE ON THE ORIGINAL RECORD.

and scientific interest aroused by this storm a brief account of authenticated events associated with it has been prepared.

Magnetic records from the Coast and Geodetic Survey Observatory at Cheltenham, Maryland, show that the storm began at 8^h 50^m, Eastern Standard Time. At 10^h 45^m an interval of unusual violence began, reached its maximum intensity about 12^h, and continued until about 14^h. A high degree of magnetic activity persisted until about 9^h on the following day, March 25. Variations of 1,100 gammas (one gamma equals 0.00001 gauss) in vertical magnetic intensity and 850 gammas in horizontal magnetic intensity were recorded. Since the normal horizontal intensity at Cheltenham is about 18,000 gammas, this represents a fluctuation of nearly 5 per cent. in that component. At the Niemegk Observatory near Potsdam, Germany, the ranges were about 2,000 gammas in the vertical and horizontal components of magnetic force, representing more than a 10 per cent. fluctuation in the latter component. Unusual displays of the aurora borealis were seen on the night of March 24, some visible even as far south as Tucson, Arizona. The storm was followed by two more of much less intensity on March 29–30 and on March 30–31.

The storm was associated with the passage of a moderately large active



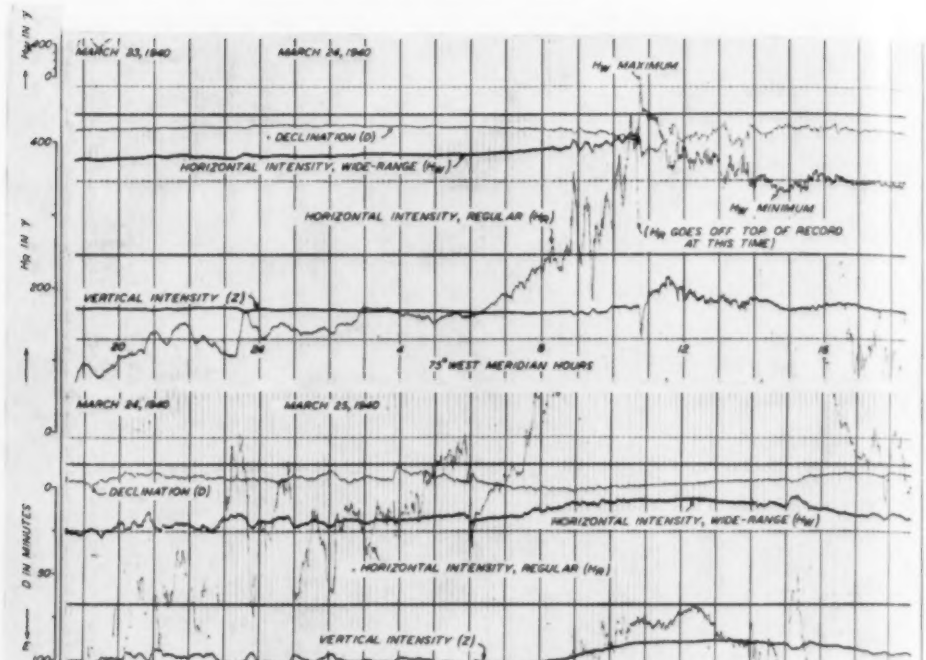
RECORDS OF THE MAGNETIC STORM FROM TUCSON, ARIZONA

MADE AT THE U. S. COAST AND GEODETIC SURVEY OBSERVATORY, MARCH 23–25, 1940. THE SIMULTANEITY OF MAGNETIC DISTURBANCE IS REVEALED BY COMPARISON OF THESE RECORDS WITH THOSE OF CHELTENHAM. BASIC FEATURES ARE REVEALED AT BOTH OBSERVATORIES MODIFIED BY LOCAL DIFFERENCES.

group of sunspots across the central disk of the sun. Although the sun showed a number of groups of spots at the time the storm occurred, the visible solar activity was not unusually great.

High-frequency radio communication was so severely affected that transatlantic channels were useless for the rest of the day after the beginning of the storm. Europe and America were practically isolated as far as communication was concerned and news broadcasters were severely taxed to find material on which to base comments on the European situation. Scheduled re-broadcasts of programs originating in Europe had to be cancelled and makeshift substitutions offered the audience—a circumstance which made the public more conscious of magnetic storms than it had ever been before. The day was the poorest on record for transatlantic radio communication.

From about $9^h\ 45^m$ until 15^h grounded telegraph lines were rendered useless because of intense earth-currents induced by the violent magnetic fluctuations. Potentials as great as six volts per mile were induced at times; fluctuations of 1,600 volts were observed on the 140-mile Western Union telegraph line between New York and Binghamton. However, communication by wire was still possible by use of "all-metallic" circuits, that is, those in which both the outgoing and incoming current is carried by wires rather than using the earth as one conductor. Under these conditions the earth-currents flowing in one wire are neutralized by those flowing in another.



RECORDS OF THE MAGNETIC STORM FROM CARNEGIE OBSERVATORY IN PERU MARCH 23–25, 1940. THE RECORDS AT THIS OBSERVATORY (ELEVATION 11,000 FEET) OBTAINED NEAR THE MAGNETIC EQUATOR—IN GEOGRAPHIC LATITUDE 12° SOUTH—EXHIBIT THE EQUATORIAL MANIFESTATIONS OF THE STORM. PERTURBATIONS WERE SO VIOLENT THAT THE ORDINARY RECORD OF HORIZONTAL INTENSITY WAS LOST, BUT A COMPLETE REPRESENTATION OF THE VARIATIONS WAS OBTAINED BY THE WIDE-RANGE RECORD. A TOTAL CHANGE OF 1,400 GAMMAS WAS RECORDED, NEARLY 5 PER CENT. OF THE TOTAL INTENSITY OF THE EARTH'S FIELD AT THIS STATION. THIS IS THE GREATEST FLUCTUATION EVER RECORDED IN EQUATORIAL REGIONS.

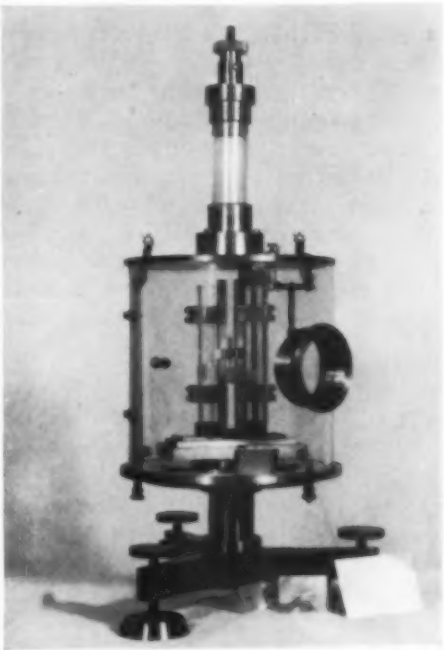
Such conditions seriously handicap telegraph companies, since twice as many wires are required to carry the same traffic as when grounded circuits are used.

The most striking manifestation of the storm was its effect on electric power-lines. Most power-engineers (and magneticians, too, up to the present) have been disinclined to believe that magnetic storms could have any appreciable effects on electric power-circuits. However, here are some facts: At about 11^h 45^m the period of most violent magnetic fluctuations began and continued for about an hour. At 11^h 48^m the Consolidated Edison Company of New York experienced a dip of about 1,500 volts on the 27-kilovolt busses at the Hudson Avenue Station in Brooklyn and also at the Hell Gate and Sherman Creek stations in the Bronx, the disturbance continuing for an hour or more. At 11^h 48^m protective relays on two transformers of the Pennsylvania Power and Light Company were operated, the effects continuing until 12^h 45^m. At 11^h 49^m protective relays at a station of the Hydro-Electric Power Commission of Ontario were operated with subsequent loss of generation at that station. None of these systems was tied in to either of the other.

In view of the close coincidence of these independent but similar events

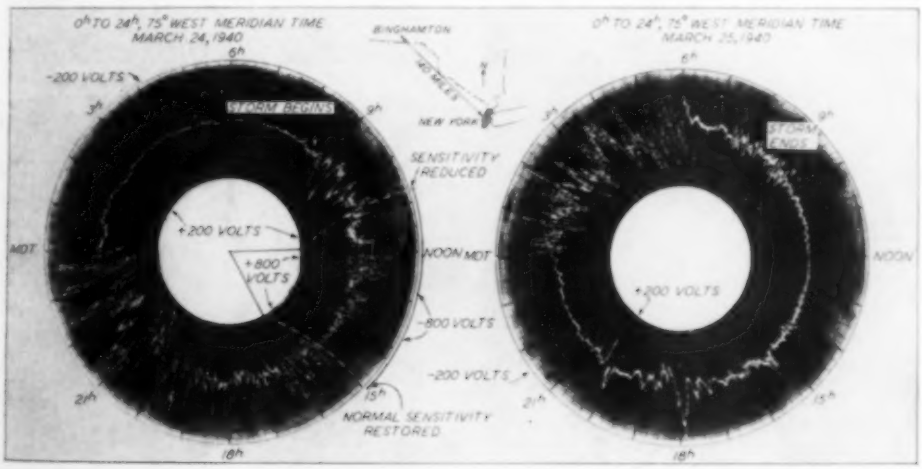
there appears little room to doubt their cosmical origin. Skeptics may still believe that these effects were due to equipment failure, but the preponderance of evidence indicates that they were due to natural causes beyond human control. As far as we have been able to ascertain no such effects have ever been reported before.

Our knowledge of great magnetic storms is limited. They occur at rare intervals, although several storms of unusual violence have appeared during the present sunspot-cycle. Because of their rarity, students of geomagnetism have focused attention on observing and studying the lesser fluctuations of the earth's magnetism, and magnetic instruments have been adjusted to so high a sensitivity that perfect records of great magnetic storms are obtained at only a few observatories. Because of their effects on our complex systems of electrification, interest in these storms is growing and additional equipment for faithfully recording them is being installed.



A NEW INDUCTION-VARIOMETER

DEVELOPED AT THE CARNEGIE INSTITUTION OF WASHINGTON TO MEASURE VARIATIONS IN VERTICAL MAGNETIC INTENSITY.



Courtesy Western Union Telegraph Company

EARTH-POTENTIALS BETWEEN NEW YORK CITY AND BINGHAMTON, N. Y.

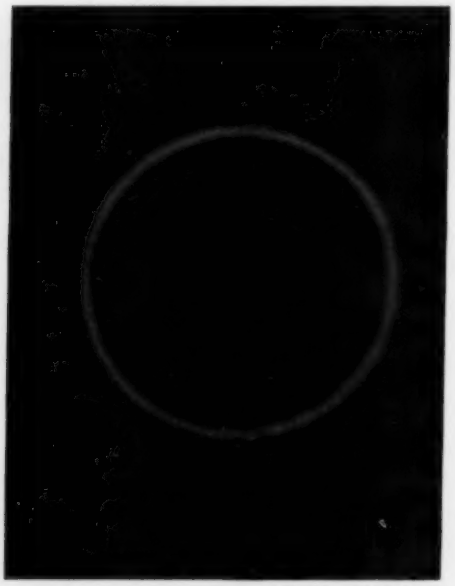
DURING STORM OF MARCH 24, 1940. RECORD TO LEFT WAS STARTED AT MIDNIGHT MARCH 23 AND AFTER COMPLETING THE CIRCLE ENDS AT THE STARTING POINT AT MIDNIGHT MARCH 24. IT REVEALS UNUSUAL DEVELOPMENTS OF POTENTIAL AT ONSET OF STORM; AT $10^h\ 45^m$ POTENTIALS BECAME SO GREAT THAT SENSITIVITY OF VOLTMETER HAD TO BE REDUCED; NOTE RECORD AROUND NOON OF FLUCTUATIONS FROM −800 TO +800 VOLTS. THE RECORD ON THE RIGHT WAS STARTED AT MIDNIGHT ON MARCH 24, AND AFTER COMPLETING THE CIRCLE ENDS AT MIDNIGHT MARCH 25.

Was this the greatest magnetic storm ever recorded? The answer to this question must await examination of magnetic records from many parts of the earth because the aspects of magnetic storms change from place to place. Considering only the reported range of variation this storm was not much greater than the one which occurred on April 16, 1938, but the duration of that storm was much less. The recent storm did not last as long as the one which occurred in May, 1921, but the latter did not produce as great fluctuations. However, when the final account is taken it seems likely that, considering both intensity and duration, the great storm of last month, which made front-page headlines all over the country, will appear as the greatest magnetic disturbance which has ever been recorded.

J. A. FLEMING, *Director*
DEPARTMENT OF TERRESTRIAL MAGNETISM,
CARNEGIE INSTITUTION OF WASHINGTON

ANNULAR ECLIPSE OF THE SUN

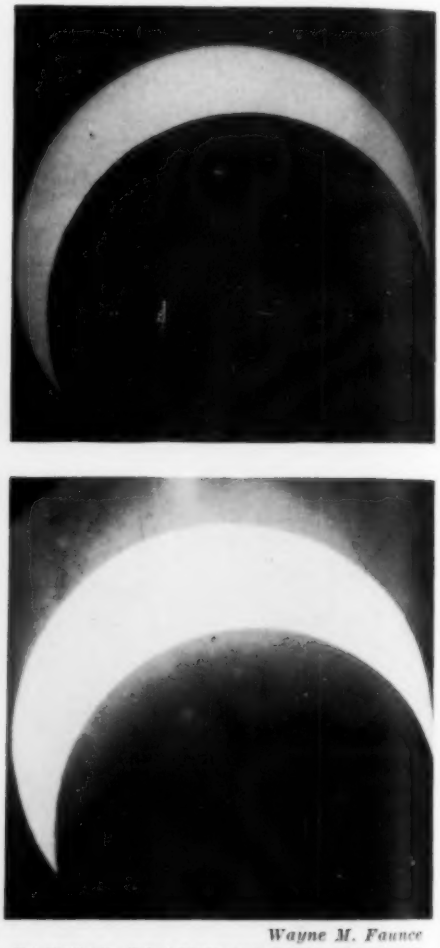
THE Hayden Planetarium-Longines Eclipse Expedition successfully photographed the annular eclipse of April 7. Photographs were made from two stations, one on the roof of the Barnett National Bank Building in the heart of Jacksonville, Florida, the other from an airplane.



Charles H. Coles

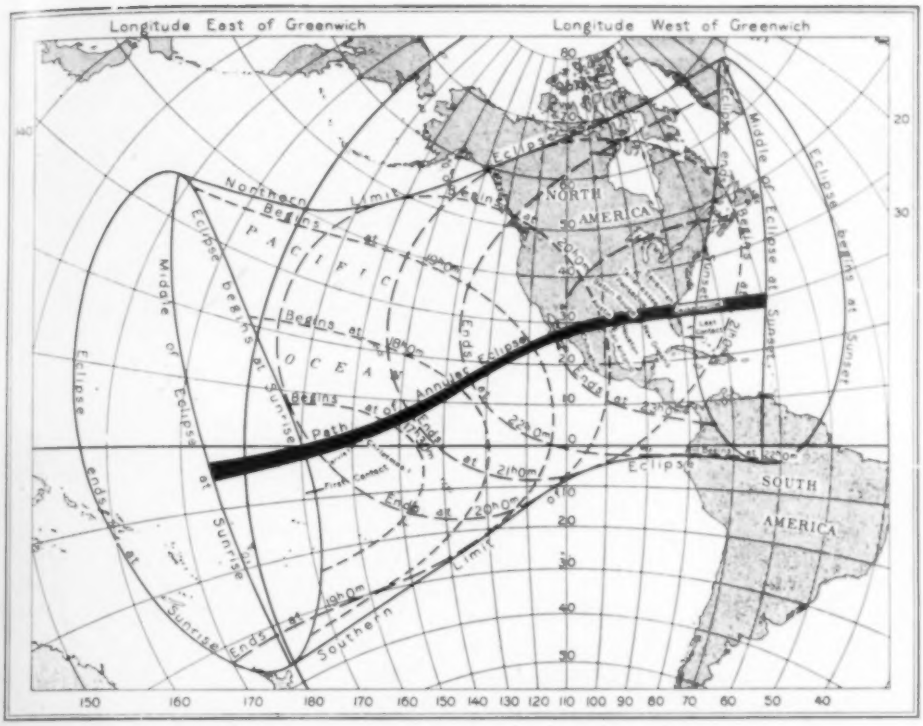
THE ECLIPSE FROM AN AIRPLANE

APRIL 7, 1940, ABOUT 40 MILES NORTH OF JACKSONVILLE, FLORIDA, AT AN ELEVATION OF 16,200 FEET. THE UNIFORM THICKNESS OF THE RING OF SUNLIGHT INDICATES THAT THE PICTURE WAS MADE FROM THE MIDDLE OF THE PATH.



Wayne M. Faunce

PARTIAL PHASES OF THE ECLIPSE, JACKSONVILLE, FLORIDA


Longitude East of Greenwich
Longitude West of Greenwich
NORTH AMERICA
SOUTH AMERICA
PACIFIC OCEAN
Northern Limit of Path
Southern Limit of Path
Middle of Eclipse at Sunrise
Middle of Eclipse at Sunset
Eclipse begins at Sunrise
Eclipse ends at Sunrise
Eclipse begins at Sunset
Eclipse ends at Sunset
Path of Annular Eclipse
Begins at 19h 0m
Ends at 23h 0m
Begins at 21h 0m
Ends at 20h 0m
Sunrise Ends at 19h 0m
150 160 170 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40

THE PATH OF THE ANNULAR ECLIPSE, APRIL 7

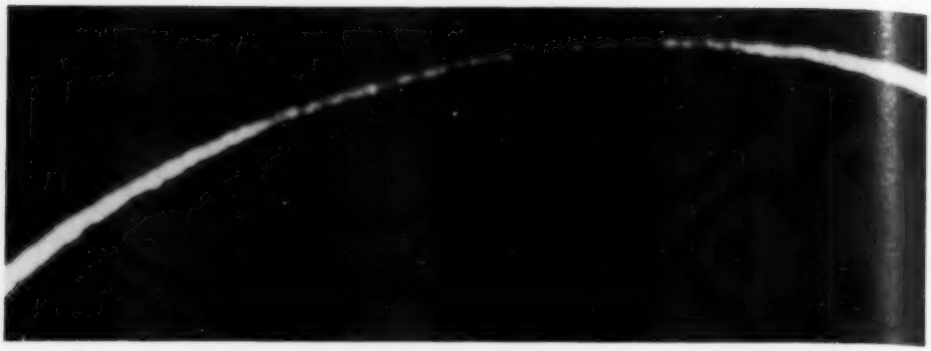
THE HOURS OF BEGINNING AND ENDING ARE EXPRESSED IN UNIVERSAL TIME OR GREENWICH CIVIL TIME

Eastern Air Lines Silverliner. A two-way description between the observation stations was broadcast over the radio.

At the ground station, Mr. Wayne M. Faunce, of the American Museum of Natural History, made a series of photographs with a 4-inch telescope attached to a Graflex camera. He secured pictures of the partial and annular phases. What is more important, one exposure showed Baily's Beads. We are likely to associate this phenomenon with total eclipses only. It is not generally known that Baily discovered this breaking down of the sun's light into a series of points at an annular eclipse in 1836. Baily's Beads were not observed visually by either those on the ground or those in the plane. No trace of either solar or corona prominences was seen.

The sky was partly overcast by broken cumulus clouds at a low level and a layer of thin clouds the top of which was at an elevation of about 35,000 feet. From the ground the sun was not continually visible but was sufficiently so to observe all phases of the two-hour-and-a-half period when the sun was eclipsed. The first contact was made at about 3:39 P.M., E.S.T., and the second contact at about 5:05 P.M. The annular phase lasted until about 5:10 P.M., the last contact being at 6:12 P.M.

The plane took off at 3:50 from the Jacksonville Airport. Representing the Hayden Planetarium were Mr. Charles H. Coles, photographer, and the writer as observer to broadcast. The plane climbed quickly through the broken clouds and to an elevation where the clouds above were so thin that they did not obscure the sun sufficiently to make observing difficult. By this time the moon had cut the sun down to a rather



Wayne M. Faunce

A SECTION OF THE CRESCENT SHOWING BAILY'S BEADS

THE BRILLIANT SPOTS ARE PRODUCED WHEN THE MOUNTAINS COMPLETELY COVER THE SUN'S DISC, ALLOWING THE SUNLIGHT TO REACH THE EARTH THROUGH THE VALLEYS ON THE MOON.

thin crescent. It was somewhat surprising that even though the area of the sun was diminishing rapidly, the light did not seem to fade in the same proportion. The clouds below were pearly gray with tints of pastel shades like the inside of a shell. Around the horizon a rim of darkness was noticeable, apparently heavier cloud or shadow. Above, the sky was a vague gray, uniform in tone. It might have come from a change in color in the sky light or merely from clouds.

Even when the annular phase was in progress with 86 per cent. of the sun's area covered, the light was bright, giving the impression of a cloudy day with no particular color to the scene.

During the annular phase and once afterward beautiful sun dogs were seen. They were brightly colored, and it may be more than a coincidence that Mr. Coles saw the same thing in Peru in 1937 when we observed the total eclipse from the top of the Andes, at an elevation of nearly 15,000 feet.

Mr. Coles made several pictures of the various phases with a 20-inch Fairchild aerial camera.

The broadcast was marred by static and there was some difficulty maintaining contact with members of the other party on the ground and hearing them. Perhaps the expedition studying short wave problems in Texas may be interested in our troubles.

The Army Air Corps was also in Jacksonville and one of the new flying fortresses under the command of Major George W. Goddard flew to about 38,000 feet and photographed the eclipse with a 60-inch aerial camera.

A group of amateurs under the auspices of the Amateur Astronomers' Association of the Hayden Planetarium observed from St. Augustine and a few from a charted plane out of Jacksonville.

Despite the uncertainty of the weather before (and even during) the eclipse, things seemed to work out satisfactorily.

My good friend, Dr. John A. Miller, who has chased eclipses all over the world, admits that no party ever returns completely satisfied. This, perhaps is the incentive that leads one to the next eclipse.

WILLIAM H. BARTON, JR.,
Executive Director
THE HAYDEN PLANETARIUM